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MAGAZINE OF WORLD ASTRONAUTICS

-4 Per

News and Business Edition

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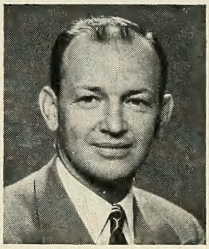
HIGH TEMPERATURES
Key to Missile Performance

by John V. Long, Director of Research, Solar Aircraft Company



HIGH TEMPERATURE presents a formidable barrier to the advancement of missile technology. Present defense requirements call for temperatures ranging from −460F to way beyond the limits of known material capabilities. New and planned developments in atomic power and space flight will mean temperature levels far outside of man's current experience.

The temperatures encountered in missile development produce startling phenomena. They are part of today's problems—affecting the very concept of the new generation of high-Mach aircraft and missiles. Laboratory experiments have produced temperatures in the million degree range. Nuclear fission and fusion reactions produce temperatures even higher.

In the all out attack on the thermal barrier, scientists and material researchers are probing the four corners of the periodic table. The goal is to develop a practical solution to the thermal problem.

The highest melting material reported is a combination of the carbides of tantalum and hafnium. Its melting point is about 7200F. Difficulty of fabrication, however, precludes its use in present day applications. And 7200F is at the cold end of the high temperature spectrum. It is obvious, then, that a solution to the materials problem cannot be based on melting point alone. Man will never beat the thermal thicket by hitting it head on. Success will come only when he has devised new methods of ingeniously avoiding it.

There is an immediate need for a combination of materials and designs which will withstand temperatures of 2000F in jet engines —and at least 20,000F for re-entry vehicles.

In an all-out effort to satisfy some needs, materials researchers are re-evaluating available elements, combinations and processes. New techniques including vacuum metallurgy, zone refining, powder metallurgy, dispersion hardening and others are providing improved metals and alloys. Molybdenum, tantalum, rhenium and tungsten show promise because of their high melting points. But no known material has the refractory property or structural integrity to withstand the temperatures that will be encountered in tomorrow's "hotspeed" aircraft and missiles.

Extreme temperature resistance is not just a materials problem, but a problem of interaction between environment and the material of the vehicle. Designers must look at the system as a whole and design "around" high temperature problems. The use of heat sinks, ablation and transpiration cooling are partial solutions. Additional improvements will come with more research.

For the present we must learn to use available materials and, through design, provide the balance of the solution. We have by no means exhausted present material capabilities. Researchers must continue to refine and extend the high temperature performance of a variety of materials.

A comprehensive knowledge of both metals and non-metals and their physical characteristics in extreme environments is necessary for successful applications. The ability to fabricate useful structures is obviously a major criterion.

Best results will be obtained through a materials systems concept. This involves close coordination among raw materials suppliers, users, materials engineers, designers, test engineers, fabrication specialists and quality control engineers.

The team effort must be enthusiastic—and it must be dedicated to ultimate success through hard work.

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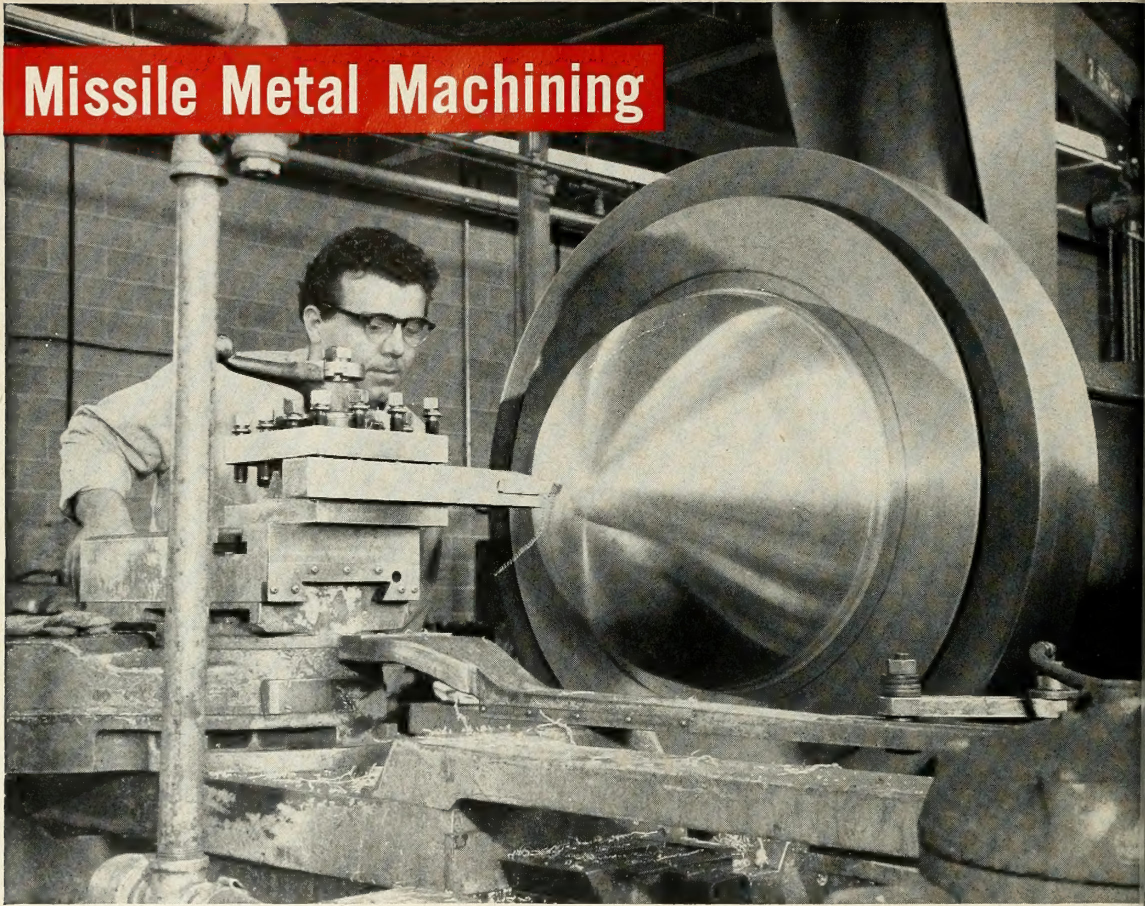

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editorial viewpoint . . .

The tremendous glare of publicity in which U.S. missile experts must work while the nation tries to catch up with Russia in the race for space has brought much serious criticism of the nation's press.

Why must the U.S. advertise its failures to the world; why must it lose face in the eyes of its allies and potential supporters, and by the same token, strengthen the Russian claims that their system can outproduce a free economy? Isn't the insatiable curiosity of the U.S. press due for curbing, on the ground it injures national policy and prestige?

This kind of criticism—unfortunately coming sometimes from intelligent and highly-placed individuals—concerns us greatly. This publication has an even greater interest in such publicity than does the general press. And like all members of a free press, it has an obligation beyond that to its own specialist readers: A duty to keep the general public informed on matters in which m/r has special competence.

The facts and the reasons should be clear in everyone's mind: True, the Russians do not announce their failures, only their successes. But it is also true that Mr. Kruschev's captive taxpayers and servile press have no right to know the truth—and no means of obtaining it.

But the right to know the truth, and the equal right to know what's being done with taxpayers' money are vital to the conduct of a democratic form of government. More, the right to criticize, to demand an accounting from any official—no matter how high his position—are more than rights, they are duties. And the public press—asking questions for, and speaking for the ordinary citizen—must assume these duties. The business press, such as ourselves, must add still another duty: If the science of missilery, for a specific case in point, is to advance, its practitioners must know at once what has been done, what concepts were involved, and what happened.

It is of course a sad thing that the whole world is told of our plans and—in the event of an attempt at a moon shot—of our failure. But it is also vitally important that our own citizens know of our plans, and also know that there is no magic button called "American know-how" that can be pushed. It is of equal importance that our scientists and technicians know as much as possible about why the failure occurred, so that they can see to it that it does not happen again.

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contents

news

IAF Meets In Amsterdam
by Eric Bergaust 10
Foreign Missiles In the News. 12
Earth To Moon in 80 Hours? 13
85th Congress Ends Significant Session
by Erica Cromley 14
Missiles, Men, Production ... 20
WESCON Show Reflects Industry Health 26
Instruments Survive Re-entry . 28
Thompson Products Assembles A Special Team
by Richard Van Osten .. 32

columns

Industry Countdown 7
Washington Countdown 9
Propulsion Engineering 17
Missile Business 24
West Coast Industry 25
World Astronautics 29

departments

Contract Awards 24
Missile People 34

cover

Dr. Leonid I. Sedov, Soviet space satellite expert and well-known scientist. He holds the dual posts of Academician and Chairman of the Commission of Astronautics, Academy of Science, USSR. (See p. 10).

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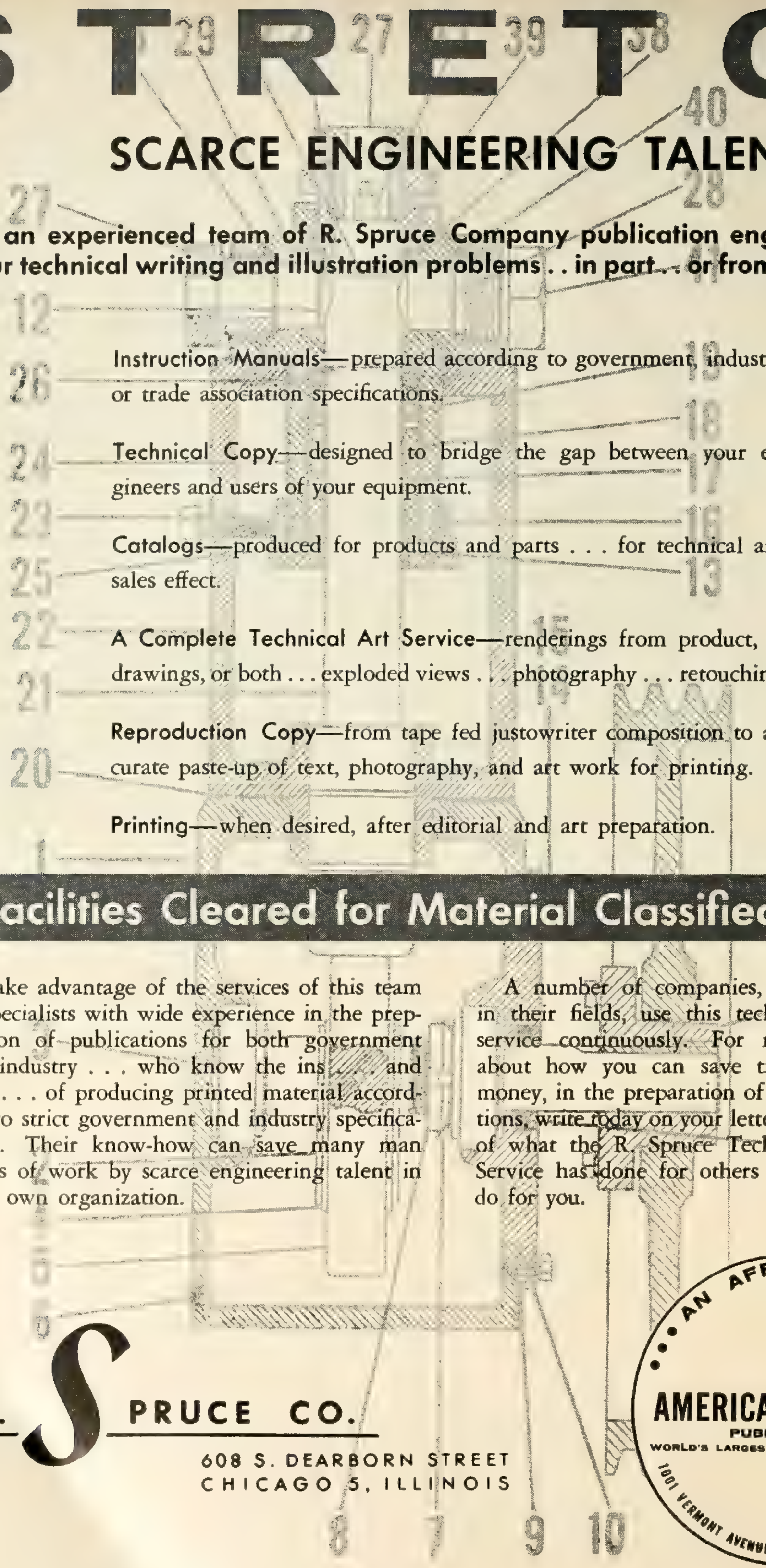

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INDUSTRY COUNTDOWN

GOVERNMENT

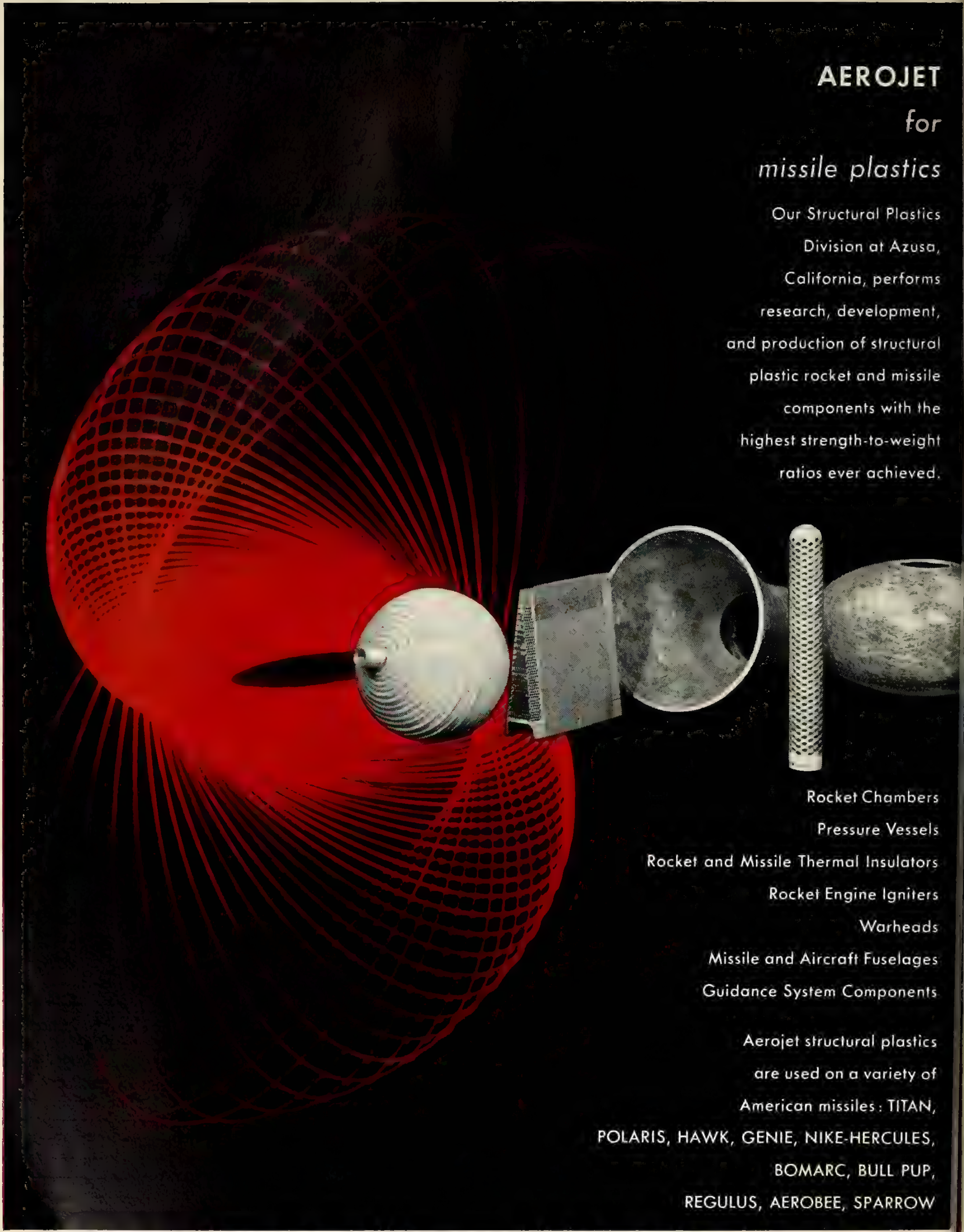
DOD control of security continues to tighten with the announcement that **Security Review Branch, Office of Information Services, USAF** has been abolished and its functions transferred to **Murray Snyder's Office of Security Review** . . . Because of the fear that rising costs will force the elimination of "at least" one major weapons system from the Air Force program and possible changes in Navy plans, **the Pentagon is busily engaged in a major reprogramming** for FY 1959 . . . **Newest of ARDC's 22 liaison offices** has been opened at the Naval Explosive Ordnance Disposal Technical Center, Indian Head, Maryland. The center is the primary R&D location for Army, AF, and Navy in providing techniques and devices for making safe and disposing of all types of explosive ordnance materials . . . On orders of the Assistant Secretary of Defense, Research and Engineering, **the Defense Metals Information Center has been established** at Batelle Memorial Institute in Columbus, Ohio. In addition to government agencies, defense contractors and other suppliers may use the services of the Center, which will collect and disseminate information on titanium, beryllium, refractory metals, high strength alloys for high temperature application, corrosion and oxidation resistant coatings and thermal protection systems. Information will be made available to the general public through OTS, Commerce Department . . . Two bills (H.R. 8711 and H.R. 8948), under study by the House Armed Services Investigation Subcommittee, will be presented to the 86th Congress. **Both propose amendments to the procurement act** and are a partial result of hearings held by the subcommittee in July.

EXPANSIONS

Lear Inc. broke ground for its 172,800 sq. ft. plant to be used for manufacture and assembly of missile sub-systems including gyro platforms for the *Bomarc* and *Nike-Zeus*, and servo control units for the *Sergeant*. Completion is scheduled for May, 1959 . . . Utah Governor George Clyde and Lt. Gen. C. S. Irvine witnessed opening ceremonies for **Litton Industries'** new 60,000 sq. ft. tube plant. Eventual employment is seen at more than 600 . . . **Westinghouse** has formed an Advanced Weapons Systems Planning Group to study over-all requirements of future military activities and to plan an integrated approach to the "weapons systems of tomorrow." Named as director was Allan Chilton, formerly chief engineer for the company's gas turbine division . . . **Epsco Inc.,** of Boston opened a new West Coast division. To be known as Epsco-West, the new division will design, produce and market the Epsco data processing and control systems . . . **Ford Motor Company's** Aeronutronic Systems Inc. started construction on a 115,000 sq. ft. computer development facility in Newport Beach, Calif. Occupancy is scheduled for August of next year . . . **The Branch Mfg. Co.** division of General Bronze Corp. announced the expansion of its magnetics program to include the manufacture of magnetic amplifiers and systems . . . **North American Aviation** has formed Aero-Space Laboratories at its Missile Division. Creative research will be the principal function of the new unit. One of the first steps to be taken will be to set up a satellite information center for analyzing data and publishing significant findings . . . **United Aircraft** is seeking rezoning of a 206-acre tract in Greenwich, Conn. for consolidation of it's recently acquired Norden Division.

PROJECTS

Project *Squid*, started over 12 years ago by the Office of Naval Research and managed by Princeton University, has expanded its work in propulsion basic research to include space propulsion . . . Los Angeles division of **North American** has been awarded a contract by the **Firestone Missile Division** for the manufacture of stabilizing fins for the *Corporal*. NAA will produce the metal honeycomb fins at Torrance, Calif. . . . The first military procurement of packaged liquid rocket engines was awarded recently to **Reaction Motors division of Thiokol.** The engine, which is an integral unit including propellant tankage, thrust chamber and all necessary components for operation, is said to be for an air-to-air missile (most likely *Sparrow* III) because of its small size. RMI is working on other size packages for future missiles of all sizes. Great advantage is that none of liquid's high thrust is lost even though engine can be stored in the same manner as a solid-propellant . . . *Polaris* mockups will be tested in a sort of "reverse slingshot" being constructed by **U.S. Steel** at the San Francisco Naval Shipyard. Test program, known as "Project Skyhook," will catapult concrete dummies in the air and catch them at the top of trajectory with steel cables to prevent the mockups from falling into the bay . . . **Western Electric** is being mentioned as the likely manager for the Cambridge Air Research Center when it is turned over to industrial management . . . **Marquardt Aircraft** reports that its new Astro Field Laboratory near Saugus, Calif. is now in operation. Work there is concerned with advanced combustion and aerodynamics . . . First of the 24 *Matadors* ordered by the West German Government are not likely to be delivered before mid-1960.



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WASHINGTON COUNTDOWN

Despite persistent rumors to the contrary, neither Boeing nor the Martin/Bell team has the edge in the competition to nail down the *Dyna-Soar* program. Though Boeing frequently has been reported out in front, the large amount of Air Force money spent with Bell in such work, and the broad background of the Martin/Bell team, cannot be discounted. The dual effort points up the recommendations of the House Committee on Government Operations, which recently reported in favor of controlled parallel effort in the preliminary stages of such projects.

And then there is always the possibility that the Air Force will decide to choose the better elements from each team and start on the R&D cycle with a completely reshuffled new team, comprising partners from both the old teams. In any case, when the program shakes out, don't look for any drastic reductions in any one team member's efforts. The time will then be about nigh for the inevitable follow-on to *Dyna-Soar.*

With the recent lunar probe failure and half-announced plans for September and October attempts, moon gazers are almost all looking to the Air Force. However, don't discount the Army. Last week, a top Army spokesman told m/r that the Army is prepared *now* to carry out any schedule of moon probes called for. Rumors around town were placing the earliest date for an Army try as sometime in October, but recently, the date has been upped to December.

The Committee for Economic Development has published a pamphlet called "The Problem of National Security—Some Economic and Administrative Aspects." The committee, headed by James F. Brownlee, New York investment banker, analyzes the current threat to U.S. security. It makes some pretty strong recommendations: Total dollars for defense should be sufficient to limit the choices between various types of military and other programs; a sharp distinction should be made between what people are willing to spend for defense and what they are able to spend without weakening the economy; the whole weapons system concept needs a new look, and choices should be made on the basis of more information and more systematic investigation; R&D procurement practices should be revamped to give contractors more discretion; and efficiency should be increased in defense management.

The pamphlet goes into somewhat greater detail about each of the broad recommendations. Essentially it recommends an end to the normal "business as usual" philosophy.

Speaking of weapons system concepts, the House Armed Services (Rep. Hebert-D-La.) Investigation Subcommittee will hold hearings, probably in November, on "soaring costs" involved in this area. Specifically, the probe will dig into the relationships between prime and sub-contractors and the "team" concept of sharing weapons development, although Congressional spokesmen say that all phases will be explored. Also due for inspection is the subject of government-owned machine tools for private industry. Emphasis here will be on methods of inventory and dissemination of inventory.

And you can depend on the Hebert group taking a much longer look at the utilization of a large number of ordnance and other unused government plants to prevent construction of duplicate new facilities for private contractors. Sort of a follow-on to the Indian Head (Md.) Naval powder factory probe that the committee conducted last month. The charge was that Navy paid Aerojet-General several millions of dollars for solid-propellant production facilities, while ignoring its own plant, which had large-grain capability. Aerojet, by the way, was exonerated.

Sedov: Man In Space Is Next Soviet Goal

• Academy of World Astronautics Proposed

• Confusion Mars Biggest International Space Meet

By Erik Bergaust

AMSTERDAM—To put man in space soon is the Soviet's immediate goal. Dr. L. I. Sedov (see cover picture) and K. F. Ogorotinikov told mr/r editors here during the ninth International Astronautical Federation Congress.

Biggest Russian delegation ever to attend an IAF Congress was made up of top Soviet astronautical scientists. It included: Academician L. I. Sedov, chairman; Dr. K. F. Ogorotinikov, Professor V. I. Krassovsky, Dr. V. G. Kostomarov, delegation secretary. Also attending from the Soviet union were four Moscow science teachers (see box).

The Russian delegation, which swept in from Moscow in a plush TU-104 jet, was the center of interest from the large world press group covering the IAF meeting.

In an exclusive interview with m/r, Professor Ogorotinikov, famous Leningrad astronomer, said: "We are pushing the man in space program hard. This is the big thing; we are making fine progress. The re-entry problem has been solved."

Asked whether the Soviet space attempt would involve a live animal or a recoverable satellite, the Russian delegate said such a deed "would be part of the program."

Considerable confusion resulted from contradictory stories in the various press reports emanating from Amsterdam about Russia's moon rocket program.

One such story quoted Dr. Sedov as saying: "We are going to wait for the result of American experience on a moon rocket. Time will show how long we are prepared to wait."

Another report, based on "reliable Russian sources in Amsterdam" indicated that "the communist will hit the moon any day."

Top m/r Coverage For IAF Congress

The Ninth Congress of the International Astronautical Congress was attended by two m/r editors, two of its staff of contributing editors, and three members of the publication's Editorial Advisory Board.

On hand in Amsterdam last week were: Erik Bergaust, editor; Anthony Vandyk, European Director; Frederick C. Durant III and Dr. Hubertus Strughold, columnists and contributing editors; Dr. Wernher von Braun, Dr. Eugene Saenger and Robert P. Havilland, editorial advisory board members.

But in an interview, Dr. Sedov told m/r editors: "These newspapers interviews make me sick. Why not wait until after our next shoot?"

Ogorotinikov said, "Why boast now? Why not wait until after we have accomplished something?"

The Russian delegates were constantly trailed by newsmen and photographers, but said little or nothing about their space program.

Dr. Sedov added that he had been "somewhat" misquoted in m/r at the last IAF congress in Barcelona, when this magazine reported that Russia was putting full emphasis on a full fledged moon rocket program. "This," Dr. Sedov said, "is only part of our story."

Dr. Sedov was offered the presidency of the IAF for 1959, but said he would rather wait a couple of years.

• U.S. has top group—The attention the Russian delegation commanded, however, obscured the very high caliber of the U.S. delegation. Not only was the U.S. quantitively, the best represented nation at the IAF, but qualitywise was undoubtedly tops. Among the most prominent Americans were ARPA's chief, Roy W. Johnson, Dr. Herbert York, Dr. Theodore Von Karman, Dr. Joseph Kaplan, Dr. Richard Porter, Dr. S. Fred Singer, Dr. Hubertus S. Rughold, Robert P. Havilland, and Dr. Fred L. Whipple.

Observers agreed that the quality of the American papers presented at the Amsterdam session was higher than those given at last year's IAF congress in Barcelona. It was clear, however, that security consideration had weakened the U.S. contribution.

•Confusion reigns—Despite the fact that nearly all the delegates planned to use some of the time in Europe to visit the British Airshow in Farnborough, some took time out from the Amsterdam sessions to make sight-seeing trips to Brussels and the World Fair, and IAF officials were much concerned that participants might not appear at sessions.

Like most of the previous IAF Congresses the Amsterdam meeting was dominated by confusion and frustration as far as the organizational and business-meeting aspects was concerned. Despite tremendous effort from IAF and Andrew G. Haley, the meeting was a flop from the press viewpoint. There was no coordination with the press and no reprints of papers available.

Many top reporters, who had traveled thousands of miles to attend the meeting, left after a couple of days in disgust. Delegates, too, complained bitterly about the organization or lack thereof. Above all, interpretation facilities were lacking, and for the vast majority of the delegates who were not linguists, much of the value of the sessions was lost. "The IAF must realize that the world is changing, and the IAF must change with it," one prominent U.S. delegate told m/r.

• Block school proposal—President Andrew G. Haley told m/r he is fully aware of the need to update IAF to take account of the tremendous devel-

Von Braun Injury Causes Concern

The U.S.' Dr. Wernher von Braun found himself accused—through no fault of his own—of "sabotaging" a meeting of the Amsterdam IAF meeting, when he failed to deliver a scheduled paper, or to appear at a swank reception given by the City of Amsterdam at the Rijksmuseum.

Reason was a painful one: Van Braun fell in his room, while bending to pick up a paper from the floor. Physicians believe he suffered a slipped spinal disc in the accident.

Well enough to talk to m/r, though obviously in pain, he smiled at the talk his absence had occasioned. And he added a point of great interest: "As everyone knows, we tried to keep it a big secret. But we (Army) will try our moon-shoot in October."

Memo to: U.S. Educators

Pointing up the Russian space flight education plan was the presence at the IAF Congress of four educators as members of the eight-man Russian delegation.

They were: Dr. P. V. Pshenichsy, Dr. V. V. Zlaoga, Dr. V. Y. Likhusin and Dr. P. V. Sporojenko.

Their presence lent point to the fact that no other nation is pushing education in space flight. Dr. K. F. Ogorotinikov told m/r that the Academy of Sciences is establishing a new university in Siberia. Part of the new unit's work will be in astronautics.

opments in Astronautics that have aken place in recent years, but he is having "a hard time" carrying through these changes because of the shortsightedness of certain delegations.

Sweden's delegates, for example, were doing their utmost to block Haley's proposal for the establishment of an International Academy of Astronautics. This would be a research institute charged with the task of achieving space flight for non-military purposes.

The Swedes turned their thumbs down in this idea because they were afraid that international astronautical research would be concentrated in one country, rather than be spread all over he world. Haley's concept of an Astronautical Academy, however, does not call for any concentration.

The British are also against the idea of an Academy, because they consider hat IAF is not economically capable of carrying on such an ambitious project.

However, Haley told m/r the Academy has been assured the backing of many of the world's most important astronautical nations, including the Soviet Union.

• **New task for IAF**—The extent of which IAF is achieving heightened stature is reflected in the fact that the International Radio Consultative Committee of the International Telecommunications Union has agreed to investigate an IAF proposal concerning the allocation of frequencies to space-circling vehicles and related problems.

These six points are to be studied by the committee:

1) What frequencies are especially suitable for penetration of the layers of the earth's atmosphere?

2) What are the influences on these frequencies of the hour of the day, season, the geographical location and solar activities.

3) What deviation in propagation direction can be expected by the penetration of the ionosphere?

4) What—if any—will be the differences in propagation between ingoing and outgoing signals relative to the earth?

5) Are special phenomena to be expected that do not occur in transmission between two points on earth?

6) What is the possible influence of the trophosphere on wave propagation to and from extraterrestial objects?

• **Propaganda war**—During the IAF congress m/r learned that the Russians are planning to give 500 satellite tracking telescopes to foreign countries, including Argentina and Poland, to encourage the advancement of astronautics. The Soviet give-away-program undoubtedly will be accompanied by maximum propaganda once it gets underway.

The United States has a program to counter this Soviet hand-out-scheme, m/r established in Amsterdam. However, red tape has bogged down the American program, which calls for handing out some 400 satellite tracking telescopes. "Washington has a heavy responsibility for this duty in a program where time is of utmost importance," one U.S. delegate said.

New member societies admitted to IAF during the Amsterdam meeting were from the following countries:

Japan, Canada, Nationalist China (after the Soviet delegation had tried to block it), Greece, Israel and Bulgaria. India, Hungary, and Czechoslovakia were given status (further details of the IAF congress will appear in the Sept. 8 issue of m/r).

British Setting Up First IRBM Units

The first British IRBM unit has been set up by the Royal Air Force.

A squadron of the Bomber Command will get its first missiles shortly, according to information at the Amsterdam IAF meeting. First activity for this unit, to be commanded by Group Captain F. A. Wilan, will be to improve test installation, and train personnel. USAF technical personnel will be attached to the British unit during the training period.

Four Members Added To Senate Space Committee

Four senators—Margaret Chase Smith (R-Me.), Carl Hayden (D-Ariz.), Robert S. Kerr (D-Okla.), Jacob K. Javits (R-N.Y.) won places on the Senate Space Committee, bringing total membership to 15, and assuring permanent status for the committee.

Other members of the Committee are: Sen. Lyndon B. Johnson (D-Tex.), chairman; Sens. Richard B. Russell (D-Ga.); Theodore F. Green (D-R.I.); Warren G. Magnuson (D-Wash.); Clinton O. Anderson (D-N.M.); Stuart Symington (D-Mo.); Styles Bridges (R-N.H.); Leverett Saltonstall (R-Mass.); Alexander Wiley (R-Wis.); John W. Bricker (R-Ohio); Bourke B. Hickenlooper (R-Iowa).

Hydrogen Fusion Engine Development Underway

VANCOUVER, B.C. — Research aimed at developing a fusion engine, which some scientists have theorized could provide power for a space flight through the entire solar system, was described here last week at a meeting of the American Physical Society.

Nicholas Christofilos, physicist at the University of California Radiation Laboratory, Livermore, described the construction of an Astron—a device being developed to test a new approach to the generation of the monuclear power.

The experimental Astron, being built at UCRL, will use relativistic (high energy) electrons of an energy of 3,000,000 (3-mev) electron volts to test the theoretical principles. As part of the AFC's Sherwood Project, the Astron is not expected to produce power itself, but eventually to produce low cost energy from the fusion of hydrogen nucleus.

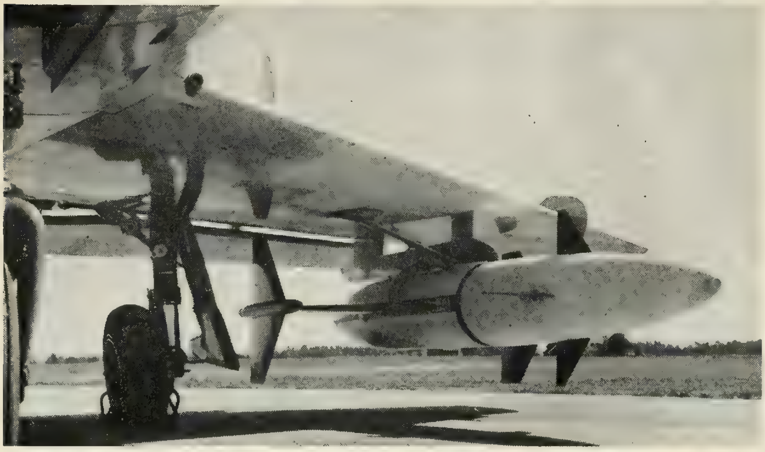
Urey Appointed Member of Space Science Board

BERKELEY, CALIF.—Dr. Harold C. Urey, University of California, has been named a member of a 16-man Space Science Board which will "survey the scientific problems, opportunities and implications of man's advance into space," the National Academy Science has announced.

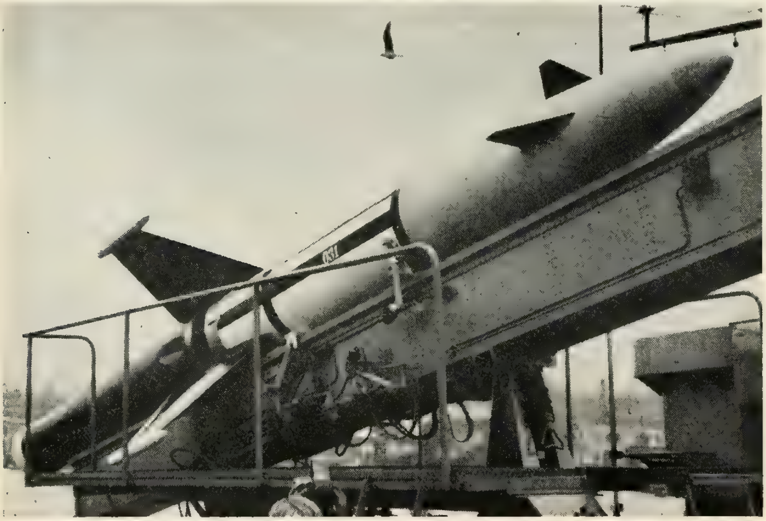
Dr. Urey will head the committee on the Geochemistry of Space and Exploration of the Moon and Planets.

The work of the new board will be coordinated with the National Aeronautics and Space Administration, the National Science Foundation ARPA and other appropriate organizations.

Foreign Missiles in the News

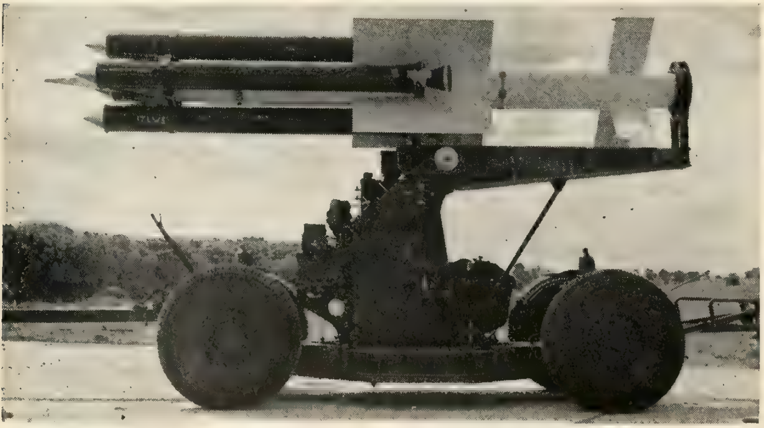


SWEDISH Type 304 air-to-surface missile mounted under aircraft wing.



Granskad Tillystyrkes

SWEDISH Type 315 naval surface-to-surface missile ready for launching.



Armstrong-Whitworth

A FOUR-BOOST propulsion test vehicle for *Seaslug* ship-to-air missile.

Sweden . . .

Sweden is equipping its Saab-32 Lansen all-weather attack aircraft with a recently-developed missile, the Type 304.

A rocket-powered air-to-surface missile, the 304 is reported to utilize all-weather guidance. The missile was developed by the Swedish Guided Weapons Bureau, and is being produced by the Swedish Air Force's production facilities, as well as by civil subcontractors.

The Lansen is armed with two of the type 304 missiles, and the combination is said to comprise one of Sweden's best weapons systems. The 304 has been under development in Sweden since 1950, and the first flight test of its structural components was conducted in 1954. Initial tests of the complete weapon began in February, 1955.

Another defense missile unveiled by Sweden is the type 315, a naval surface-to-surface missile for use from destroyers. The 315 is a jet-powered missile using four built-in booster rockets, but information released did not specify the type of jet engine as a sustainer.

Australia . . .

A new Australian anti-tank missile, named *Malkara,* has been ordered by the British government. The radio-controlled SSM weighs 200 pounds. Australia has sent 30 *Malkaras* to Britain for acceptance tests. The British production order involves the supply of 150 of the missiles. The unit price of the *Malkara* is about $60,000.

England . . .

The latest version of the Armstrong-Whitworth *Seaslug* surface-to-air naval missile uses a solid-fuel sustainer rocket, instead of the previously employed bi-propellant system with nitric acid. A *Seaslug* propulsion test vehicle with four booster rockets will be shown at the Society of British Aircraft Constructors' Show at Farnborough in the first week of September.

The *Seaslug* was developed by Armstrong-Whitworth in association with the following companies: E.M.I. Engineering Development; General Electric Co.; Sir George Godfrey and Partners; Imperial Chemical Industries; McMichael Radio; Metropolitan-Vickers; The Sperry Gyroscope Co.; John Thompson Conveyor Co.; Vickers-Armstrongs (Aircraft).

Earth to Moon in 80 Hours?

A manned vehicle will make the trip around the moon in 80 hours, possibly as early as 1963.

That's the conclusion of D. M. Cole and D. E. Muir of The Martin Company's Denver Division, in a paper presented at the American Astronautical Society meeting held recently at Palo Alto, Calif.

Cole and Muir see several ways in which the project could be approached, with practically the same hardware as would be used in a manned orbital flight, which would precede the circumlunar flight.

One method would use six to eight booster rockets to carry extra propulsion stages into orbit, to a rendezvous with the manned vehicle so that it would be able to make the longer trip.

An alternate method would use rocket stages in a cluster to make a single large booster, which would be combined with the orbital rocket and space cabin to make up the circumlunar configuration.

This method would require a theoretical three-stage rocket with stages weighing 160,000, 40,000 and 10,000 lbs., scaled up by a factor of four to make a larger, also theoretical, rocket. The four first stages would be clustered to a common engine of 1.25 million pounds of thrust and a single first stage would make the second stage on the larger rocket. The third stage of the big rocket would be a second stage from the smaller.

With such a vehicle, Cole and Muir estimate that the payload can be 20,000 lbs. Total weight would be 859,000 lbs and the thrust/weight ratio would be 1.45.

• **Computer does figuring**—A number of orbits were programmed for an IBM 704 computer, and from these, trip time was calculated as a function of initial velocity.

The accuracy requirement was found not to be as stringent as is usually thought. Actually, an uncorrected trajectory with an error no greater than plus or minus six minutes of arc s adequate. This did not take in account the fact that, on a manned trip, corrections could be made in flight with small expenditures of propellant.

The first leg of the 80-hour trip itself would take the form of a nearly rectilinear hyperbola from the earth to he sphere of influence around the moon, and would consume 35.35 hours. The second leg, a hyperbola around the moon, would take 9.3 hours and the return leg, identical to he first, would again be 35.35 hours, making the 80-hour total.

Cole and Muir see the desirability of making the approach to the moon's surface as close as possible, since the effect of the moon's gravity in bending the orbit back toward the antiparallel to the incoming leg will be greater for closer approaches. The closer the approach, the higher the initial velocity which can be used and the shorter the flight time.

An altitude of ten miles is suggested for the second leg, with the velocity at perilune 13,720 ft/sec for the 80-hour trip.

Re-entry would be accomplished by pilotage, and the control fins of the vehicle would provide sufficient aerodynamic control to permit landing in the desired area of the earth.

The Martin engineers sound a somber note in conclusion by saying that development trends indicate that Russia may already have structures on the moon when the U.S. vehicle orbits for its first close glimpse.

However, they indicate that since Russia will almost certainly make deep space flights before the U.S., our objective should be to accelerate our space efforts, with a manned trip to the moon as our specific purpose.

Speedup Scheduled For *Lacrosse* and *Bullpup*

ORLANDO—Navy, anxious to get *Bullpup* into the operational hands of carrier and shore-based tactical aircraft, has ordered a production speed up from 30 missiles per month to 600. Army is changing production of its field artillery *Lacrosse* from 15 to nearly 280 per month. The speedup will mean an around-the-clock production schedule for Martin Co.'s Florida Division.

The Air Force is also entering the *Bullpup* program, with the award of a new research and development program to Martin—aimed at giving Tactical Air Command and NATO nations improved air-to-ground missile attack capability.

Air Force, which has been in on some early testing of *Bullpup*, plans to use the 10-foot 550-pound missile on its F-100, F-101 and possibly, the F-105. However, Air Force wants internal stowage, radar acquisition of target and possibly a voice command or infra-red guidance system.

Production of the missile under the planned Air Force program will greatly exceed the Navy program, and can be expected to cut production costs from the present $5,000 per bird.

NACA to Spend $19.5 Million at Wallops

The National Advisory Committee for Aeronautics has announced details of its $19.5 million capital expansion program for the Wallops Island, Va., rocket research station.

Two launching areas, with a blockhouse between them to serve both sites, will be constructed at a cost of $4.68 million.

The launching pads will be connected to the blockhouse by a conduit system to handle communications and firing circuit lines. The blockhouse will be 40 x 60 ft., constructed of heavily-reinforced concrete, and covered with protective sand. It will be provided with blastproof doors and blastproof periscopes for viewing operations in the launching areas. Extensive tests will be made of hydrogen-flourine combinations.

The pads will have a rocket launcher, umbilical tower, and a movable service tower for loading and final check of guidance control and research instrumentation.

Rocket fuel and cxidizers will be handled by tank trailers provided by contractors, who will make deliveries as needed—eliminating the necessity for maintaining large liquid storage tanks and pumping equipment.

The 3,200-acre island, used for the past 13 years, is five miles long and one mile wide. Only 800 acres are suitable for use in rocket operations; the remainder is marshland.

A 20-ft. wide causeway over the marsh area connecting the island with the mainland is proposed. A 20-minute boat ride is now required to transport personnel and materials.

NACA, nucleus of the new National Aeronautics and Space Administration, hopes to acquire some 1,000 acres on the mainland. This land would be used for buildings and facilities—including antenna for long-range radio interferometer, radar, and telemetering equipment.

New mainland buildings planned include a two-story administrative and range control facility; a two-story model assembly and reliability check laboratory, and a one-story technical service structure.

Acquisition of approximately 800 acres of Assawoman Island—adjacent and southwest of Wallops Island, is required to provide space for the location of tracking sites and telemeter stations suitably removed from the Wallops launching area. Facilities at Assowoman Island would be designed for tracking instrumented models in flight after launching, and for recording scientific data relayed from the test models.

Wide World

Congress Racks Up Record Missile Legislation

- **$39.6 Billion for DOD Use**
- **NASA Funds Set at $80 Million**
- **Small Business Relief Okayed**
- **Reshuffle Strengthens R&D**

by Erica Cromley

Congress headed for home last week, after scaling a mountain of legislation that has been termed by some Capitol Hill veterans the most impressive and significant of the past quarter century.

The defense industries—directly or indirectly affected by much of this year's Congressional package—could be happy with most of the legislation.

Taking on the space challenge, Congress established the first civilian space agency, gave the President $39.6 billion for defense—$815 million more than he asked for—and the go-ahead to reorganize the Defense Department. Congress also provided funds for loans to promote science education.

The lawgivers also passed a host of bills designed to: create more jobs, aid depressed areas, give small business a shot in the arm, and liberalize social security benefits.

• **Space legislation**—Members of the Senate and House Space Committees clearly were not on solid ground when they tackled their first space problem: the "what," "who" and "how" to set up a government agency to direct U.S. civilian space activities. House and Senate hearings dragged on for weeks, as top government and industry scientists gave lawgivers a short course in space technology and advice.

Both sides of Congress differed over the top organizational setup, finally compromised on a nine-member council under direction of the President. The council will be composed of the Secretary of State, Secretary of Defense, the administrator of the new agency, chairman of the Atomic Energy Commission, one additional member from the government and three members from industry. Among the council's duties are to advise the President, and to develop "a comprehensive program of aeronautical and space activities." The new National Aeronautics and Space Administration, unlike the National Advisory Committee for Aeronautics, on which it is based, can negotiate contracts.

Congress voted $80 million to get the National Aeronautics and Space Administration into orbit. This is to cover: research and development ($50 million) construction and equipment ($25 million) salaries ($5 million). In addition NASA will receive NACA's $101 million 1959 funds, and another $117 million which will be transferred from the Department of Defense.

The legislators slipped a rider into two appropriation bills, which requires NASA to get new authorization for funds each year, in addition to getting appropriation approval through the legislative mill. Rider proponents finally settled for authorization approval for next year only. Meanwhile, the Senate moved quickly to confirm nomination of the two-man team named by the President to run the new space organization—Thomas Keith Glennan, director, and Dr. Hugh Dryden, deputy.

• **Defense appropriations**—The tone of urgency in the fact of the new Soviet threat permeated the session from the first day.

The $38-billion defense ceiling was lifted and the $1.26 billion emergency appropriations for the development of missiles, air detection devices and bomber facilities asked by the President, were quickly approved.

The whopping $39.6 billion defense appropriation set a peacetime high. It caused some bitter controversy: Democrats claimed the Administration was scrimping on research and defense efforts and that as a result, development of new missiles was impeded. Republicans countered with the charge that Democrats were belittling American military achievements to make political hay for the November election campaigns.

The new money bill emerged from the Senate-House Conference meeting with $1.193 billion more than the

House had approved and $440 million less than the Senate. Total for the three services were $17.877 billion for the Air Force, $11.359 billion for the Navy and $8.993 billion for the Army. Advanced Research Projects Agency (military space projects) was given a little over half a billion dollars of DOD's funds.

Increases approved included $638 million for four more *Polaris* submarines, missiles and equipment for a total of nine authorized; $90 million for acceleration of the *Minuteman* ICBM program, which includes $15 million for research and development; $48 million for the *Hound Dog* air-to-ground B 52 missile; Army modernization funds of $37 million for missiles and equipment, to which the Senate added $14 million.

(The Department of Defense recently revealed that programmed obligations for 1959 missile procurement, construction and research and development total $6.596 billion, compared to $5.107 billion in Fiscal 1958 (m/r August-11, p. 12). This includes those ship and aircraft costs directly associated with missiles, but does not include missile operation and maintenance costs, or military pay.)

Although the Congressional mood was to add to any item with a defense tag, it turned economy minded when it hit the military construction bill. The President asked for $1.73 billion; got $1.35 billion.

• **Small Business legislation**—The small businessman got a lot of Congressional attention this year.

One bill, which gave the five-year-old Small Business Administration permanent status, also raised the individual loan ceiling from $250,000 to $350,000 and dropped the interest rate from 6% to 5½%.

Small Business Gets Added Tax Breaks

In its efforts to aid small business, Congress further eased tax obligations with bills which would.

—permit certain small corporations having ten or less stockholders to be taxed as partnerships, thereby gaining a possible lower tax rate

—allow the new small business investment corporations exemption from any taxes on dividend income received from investments in small business regardless of whether they pay it out to their own stockholders; permit them to charge off their capital losses against ordinary income which is subject to a higher income tax; allow an investor in a small business investment corporation to take an ordinary loss instead of a capital loss in connection with the worthlessness or loss from the sale of stock in these corporations.

Another bill authorizes establishment of local small business investment corporations with a revolving fund of $250 million to make equity-type capital and long-term credit more easily available. To qualify for a charter, these investment companies, formed by at least 10 persons, must have a minimum capital and surplus of $300,000, half of which they can get from SBA. Loans would be limited to not more than 20% of a borrower's capital.

Small business also came in for $260 million in tax relief, included in a compromise bill which provides for a vast technical overhaul of the income tax law. Although it does not change the tax rate for small enterprises, the measure permits reduction of taxable income through deduction of a larger percentage of the cost of machinery and equipment for depreciation in the year of purchase. It permits a first-year depreciation allowance equal to 20% of the cost of investment outlays up to $10,000.

The tax law also allows business—small or large—to get retroactive tax refunds for three previous years as a result of operating losses. Formerly a loss could be carried back only to the two preceding taxable years. Included is an increase in the allowable accumulated earnings from $60,000 to $100,000 before a corporation may be subject to the accumulated earnings tax.

Another break for small business was a bill modifying certain U.S. procurement practices to help the small man get a fair share of government business. It put a new ceiling of $2,500 on open-market purchases for procurement without formal advertising.

• **Defense reorganization**—Implementation of the changes under the Defense Reorganization Act will be gradual. Prime aim is to strengthen and clarify the authority of the Secretary of Defense. For one thing, the measure puts the six unified defense commands directly under him, through the Joint Chiefs of Staff, instead of having each responsible to one of the military departments.

Assistant secretaries have been cut from eight to seven, with the post of Assistant Secretary of Defense Research, Engineering, to be upped to that of Director of RE. He will supervise, manage and direct all DOD research programs of the Advanced Research Projects Agency and the Office of the Director of Guided Missiles.

Only the Director of Research, Engineering and to some extent the Assistant Secretary of Defense (Comptroller) will be able to deal directly with the Army, Navy and Air Force.

Puzzle: What's Meaning of Spending Limit Law?

One of the least understood and most controversial of this year's laws is the bill enabling the President to propose an annual dollar spending limit for each agency.

The measure, HR 8002, originally grew out of Hoover Commission proposals aimed at returning unused funds to the Treasury, and giving the Budget Bureau and Congress control over the rate of expenditures.

However, the amendment-riddled measure that emerged was in such diluted form as to be scarcely recognizable. Under it, the Senate and House Appropriations Committees can ignore the President's spending recommendations, which gave rise to the charge that the bill created no more authority than already existed.

(The Defense Department, during hearings on the measure, estimated it would have to hire from 5,000 to 7,000 additional clerical employes if the bill became law.)

Provisions include: permission of fund transfer within an agency to retain flexibility for long leadtime weapons development; assurance that defense contractors will be paid for deliveries by permitting funds to be drawn from years other than those covered by the annual limitation, if this is necessary.

Exactly how or if it will work, remains to be seen.

• **Other action**—Other Congressional action:

—grants semi-permanent emergency contract powers to the Pentagon, similar to those of the expired Title II of the War Powers Act, including an insurance provision for otherwise non-insurable defense contract risks, authorization of certain advance payment amendments or modification of contracts on an emergency basis.

—extends for two years the government's power to set priorities for defense contracts, exempt cooperating defense contractors from anti-trust laws, authorize defense loans, and provide an emergency standby supply of trained executives for wartime posts.

—authorizes an additional $3.3 billion for mutual security.

—authorizes $888 million over a four year period to stimulate science and engineering education.

—extends Renegotiation Act for six months.

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b. Alameda, Calif., Dec. 14, 1896; m. Josephine E. Daniels; children, James Harold, Jr., John Prescott. *Educ.:* U. of California (1916-17), A.B. (1922); Massachusetts Inst. of Tech., M.S. (1924), Sc.D., fellow in Ae.E. (1925). *Business record:* mgr., aviation dept., Shell Petroleum Corp., 1930-40; present position since 1946; first to fly across U.S. in less than 24 hrs., 1922; first to fly outside loop; win-
Trophy Race, 1925; award-
hy, 1926; Harmon Trophy,
ndix Race, 1931; trans-
1931; winner Thomp-
932; advisor Congres-
icy Bd., 1948; chrm.
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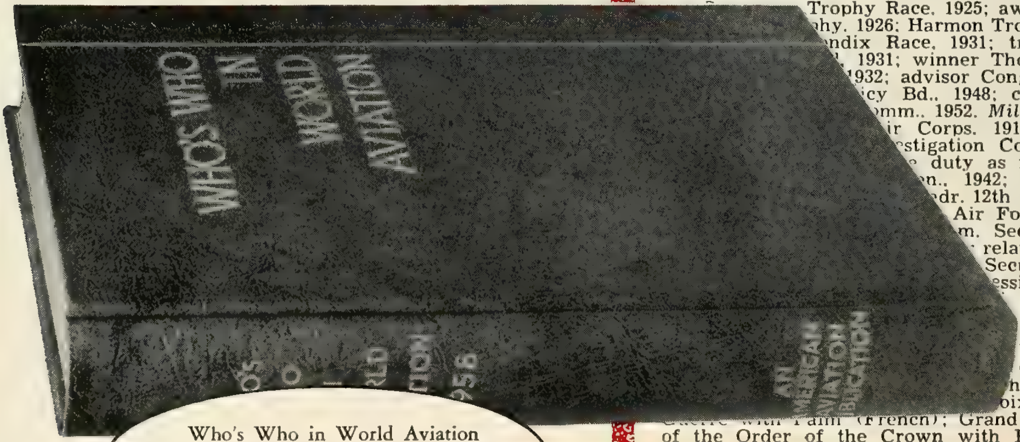

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propulsion engineering

by Alfred J. Zaehringer

Radiation definitely affects stability of hydrocarbon fuels. Tests on kerosene, gasoline, jet and petroleum rocket fuels with gamma and neutron bombardment indicate: increase in density and viscosity, decrease in hydrogen content, and the evolution of gas. Studies such as these are needed to determine optimum working fluids for atomic rockets.

Liquid ammonia is fuel for X-15 rocket plane. LOX will be oxidant. NACA calculates theoretical I_{sp} of this combination at stoichiometric as 249 sec. Volume performance is 210 lb-sec/cu. ft. This is one of the first major applications of ammonia as a rocket fuel in the U.S. It also marks one of the first uses of a liquefied gas as a fuel material. Low cost and high availability were other selection parameters.

Long run ramjet static test of a Marquardt engine at Naval Ordnance Aerophysics Lab at Daingerfield, Texas was equivalent to a non-stop flight three times around the world at an altitude of over 70,000 ft. Conducted at high supersonic speeds, the ramjet has already chalked up a total run time equal to a flight five times around the world.

Super pressures and temperatures may result in new propellants and motor materials. Research at Brigham Young University indicates that attainment of pressures of 3 million psi and temperatures of 5,000°F are possible and may result in the attainment of new physical and chemical properties for many elements and compounds.

Gas-producing cartridges for feeding liquid propellants have been described by the Vernon Laboratories of France. The solids are based on urea, urea nitrate, hexamethylene tetramine, ammonium nitrate, and ammonium hydrophosphite to produce a reducing gas, or with ammonium persulfate, to yield a non-reducing gas.

Low cost epoxies for solids may be possible with Mod-Epox introduced by Monsanto. The viscosity modifier, based on an organophosphorous compound, could allow the incorporation of higher oxidizer or exotic fuel loadings. Phosphorous improves stability—particularly thermal properties vital under high temperatures and long term storage. Reichold Chemicals, too, is entering the epoxy field and may mean higher interest in epoxy fuel-binders. The reactive epoxide group offers not only a way to form cross-linked polymers, but might also allow the introduction of exotic boron compounds directly into the molecule. Another way of attaching the borohydrides to epoxies would seem to lie in the use of Callery's amine-boranes to act as curing catalysts.

Future solid propellants will be a cross between today's homogeneous and composite propellants. So indicates Allegany Ballistics Lab. In homogeneous propellants, borons or metals may be added as discrete particles or in the form of molecular substitutions. For composites, more oxidizing power will be needed to take advantage of metals addition; this may come in the form of organic monopropellant materials. Thus, homogeneous propellants will have composite components while composites will resemble the homogeneous solids.

Safety with boron fuels may result from studies at Rensselaer. Hard to handle pentaborane can be inhibited from explosion by the addition of iron carbonyl.

New diborane process developed at Germany's Max Planck Institute for Coal Research uses boron trioxide and an aluminum alkyl. Trialkyl borane formed is reduced with hydrogen to give diborane. U.S. processes use halogen intermediates.

Engineer Survey Reports Career Motivations

Engineers would rather do engineering work, but feel there are more rewards to be gained by moving into jobs outside their technical specialization. This is one of the findings of a national survey of 1,500 engineers by Deutsch and Shea, Inc., technical manpower consultants.

More than 80% of the engineers responding to the survey felt that the greatest opportunities for advancement were outside of technical specialization. Sixty-five percent believed that administrative work offered greater opportunities, and 17% felt that more opportunities were available in the sales field.

However, only 42% of these engineers said they would be interested in leaving technical work if the salaries and opportunities in engineering were equal to those in administration and sales.

Davis Appointed New R&D Deputy Commander at ARDC

Maj. Gen. Leighton I. Davis, Air Force pilot, engineer, inventor and teacher, recently reported to Air Research and Development Command (ARDC) headquarters as Deputy Commander for Research and Development.

Gen. Davis's new position places him in control of scientific exploration programs and equipment development projects for the Air Force. This requires coordinating the efforts of Air Force and civilian scientists, and the work accomplished by numerous university and private industrial research firms.

Gen. Davis returns to ARDC after serving four years as commander of the Air Force Missile Development Center (AFMDC), Holloman Air Force Base, N.M. Prior to this assignment, he was ARDC's Director of Development, Baltimore, Md.

Manuscript Deadlines Set For ARS 1959 Meetings

Manuscript deadlines for the American Rocket Society's 1959 meetings have been announced. They are:

Dec. 15, 1958 for the Spring Meeting at Daytona Beach, Fla., Mar. 23-25; Feb. 20, 1959 for the National Telemetering Conference at Denver, Colo., May 25-27; March 9, 1959 for the Semi-annual Meeting in San Diego, Calif., June 8-11; May 22, 1959 for the Northwestern University Gas Dynamics Symposium at Evanston, Ill., Aug. 24-26; Aug. 17, 1958 for the 14th Annual Meeting in Washington, D.C., Nov. 16-20.

Meeting Urges Answer to Who Rules Space

SAN DIEGO—Urgent decisions are necessary to define the limit between regions of national sovereignty in the air space and free outer space. Legal questions on property rights on the moon and planets, and of our relations to probable existing inhabitants, can wait until we acquire more knowledge.

These were the conclusions heard recently at a jointly-sponsored meeting of the Air Research and Development Command, Institute of Aeronautical Sciences and American Rocket Society, San Diego. Speakers included Dr. Theodore von Karman, a member of NATO's advisory group for aeronautical research, and Dr. Donald L. Michael, Dunlap & Associates.

An agency for space administration might be a solution, according to Dr. Michael, if there is an increased trend to outlaw space missilery. Such a trend could result in an international impasse similar to that of atomic weapons. However, an agency could be further complicated by smaller nations who want a part in anything of international significance. This, in turn, can result in pressure groups and complex power politics.

If the UN should bear the costs of an international space program, it would still be costly to individual nations because there would be no military cost decrease—it would merely be added on.

• **Technical aspects**—Dr. George A. Hoffman of the Rand Corp., created considerable interest with a paper on the properties of "whiskers"—fine crystal filaments with phenomenal strength, in some cases approaching the theoretical limit of atomic cohesion. Hoffman said this high strength was due to a phenomena of strength increase in a crystal as its dimensions decrease, and is quite general in materials. "Whisker" materials could be woven into cables or formed into sheets with almost incredible results in tensile stress and modulus of elasticity.

However, Dr. Hoffman estimated, "it will take about two generations to develop a material made from whiskers."

With the current accent on "shots to the moon," much interest was generated by another Rand Corp. scientist, H. A. Lieske, in his paper on "Circumlunar Trajectories."

Describing possible free-flight trajectories of a moon rocket, Lieske emphasized the dependence of trajectory on burnout velocity of the final stage. The paper covered possible circumlunar trajectories from the classical "figure eight" orbit to distorted ellipses. Typical round trip flights would probably vary from 6 to 10 days, depending upon initial velocity of the rocket and the distance of closest approach to the moon.

Thermonuclear reaction power plants offer the most interesting possibilities if the basic problem of controlling the reaction can be solved, according to Dr. M. R. Clauser, director of Physical Research Lab, Space Technology Laboratories.

"There seems to be no further fundamental obstacle that would preclude its use for propulsion," Dr. Clauser stated.

Other methods being investigated, he said, are an ion rocket for use after a vehicle had been put in orbit about 200 miles above the earth, and a system of nuclear energy using the fission reaction. To accomplish a velocity of 40,000 ft. per sec., as required to encircle Mars, Dr. Clauser said this would would probably require development of an exotic propellant rocket motor—possibly utilizing a hydrogen-fluorine combination or a fission rocket motor.

• **Launch to planets**—Krafft A. Ehricke, Convair-Astronautics, said that there will be only four periods in the next ten years, each about 90 days long, when it will be possible to launch instrumented "comets" towards Mars and Venus. Modified versions of ICBMs in current development could be used.

Launches towards Mars could be made during a three-month period beginning in August 1960; other launches could be made during like periods beginning September 1962, November 1964 and December 1966.

Six favorable periods will be available for sending instruments towards Venus, but they will last only two weeks each. These will be in June 1959; January 1961; August 1962; March 1964; October 1965; and June 1967.

Ehricke also urged an early start towards such projects—"since our competitors won't wait for us."

Missile Shaker

THE 44-FT. FIRST STAGE of the *Vanguard* rocket is being inserted into the test tower at Martin Co., preliminary to undergoing a "shake" test. This test, which uses the round wire coils as "ears," is used to conduct a ground resonance survey. These coils are used in recording informations during a test, through the use of strain guages and other devices.

Enemy Imitator

NEEDLE-NOSE *Kingfisher*, the Army's new target missile built by the Lockheed Missile Systems division, can portray enemy attackers to provide a realistic test of U.S. missile-age defenses. A radar target augmentation device in the bird simulates high-flying hostile planes or missiles, and a Lockheed-developed firing error indicator records theoretical hits.

North American Aviation Highlights SAC Operation

A comprehensive roundup of Strategic Air Command operations is featured in the current issue of North American Aviation's publication, SKYLINE.

SKYLINE covers various phases of SAC's responsibilities as a major war deterrent.

Included is a four-page article on SAC's first missile division at Cooke Air Force Base, California, which will undertake the training of 7,000 missile men within a year.

Hand-Carried Infantry Missile Due For U.S.

By Raymond M. Nolan

Slated to make its appearance in the U.S. soon is the Vickers 891 anti-tank guided weapon system (m/r August 25, p. 37—see photo).

The 891 is an Infantry anti-tank weapon which can be carried, set up and fired by one man without any special technical skill. Probably the smallest portable weapon of its type, it is a simple and powerful missile which will give an infantryman a good chance against even the heaviest tank. Its only counterpart in the free world today is the French S10 and S11 series, sometimes called the "suitcase weapon." However, the French missiles are somewhat heavier than the 891.

The Vickers system is actually a two-part weapon: the missile contained in a portable launching canister or in a bag complete with launching stand, and the control device with which the operator generates the command signals. No additional computing gear is required.

Wide World.

Designed to carry big wallop—British Army paratrooper fires a close-range guided rocket missile designed as an anti-tank weapon.

• **Guidance**—The missile is guided by means of a simple optical line-of-sight command system. Before firing, a cable is pulled out from the container and plugged into the controller unit.

Steering is by a thumb-operated stick which the operator uses to bring the missile onto the line of sight of the target. The absence of any electronic or other parts in the wire-guidance system which require warming-up make the launching sequence very rapid.

Command is exercised by changes in later velocity. As the operator moves the control stick, the velocity with which the missile crosses his line of sight is changed. Commands are transmitted by a wire-wound spool attached to the rear end of the missile and encircling the rocket motor nozzle. Power comes either from batteries or a small turbo-generator.

The body has a conical nose fitted with a contact probe. The main body sections and the pressure vessel for the motor are aluminum alloy. The four wings carry trailing edge control surfaces and plastic shells reinforced with glass cloth, and are filled with foam plastic.

The two detachable fairings, lying between the wings, are also of reinforced molded plastic. They are easily replaceable and serve the twin purpose of housing the electronic components of the control system and providing means of interconnecting equipment at either end of the rocket motor.

The solid fuel motor has a removable igniter which is screwed into position just before firing. A flare is also installed to give the operator an assist in visual tracking.

•**Launching**—The missile container becomes the launcher with the removal of a rubber plug and ring in the rear-end support pad. The container lid folds down and becomes the supporting member to achieve the 20 degree firing angle for the missile. Angle of elevation is varied by propping up the rear end.

The canister is about 15 in. square and 37 in. long. It weighs from 33 to 45 pounds, complete with missile, depending on shock protection. The missile itself is 33 in. long, with a body diameter of 4.5 in. and an 11 in. wing-span.

Vickers designed the 891 with a one-man launching team in mind. The missile is light enough to be carried, accurate enough to be effective at either end of its range, and rugged enough to be transported by jeep or helicopter, or dropped by parachute. Recent rumors that an American manufacturer would produce the missile have not yet been confirmed, but m/r has learned from sources in Washington that the 891 will be in competition with the *Dart* at an early date.

Arma Sales Drop, Merger With Northrop Considered

Sales, profits and earnings on common stock of the American Bosch Arma Corp. for the first six months of this year are considerably below those for the same period last year, the company announced.

Sales for the first half of this year were $57.7 million with a net income after taxes of $1.6, as compared with sales for the same period last year totaling $69 million with a profit of $2.9.

Earnings on common stock, after provision for preferred stock dividends, were 85 cents per share as compared with $1.56 last year. The lower profits were a result of a 25% reduction in commercial products billings, according to the company.

Arma reported that several meetings have been held with officials of Northrop Aircraft, Inc., Hawthorne, Calif., to discuss the possibility of a merger. No agreement has been reached, but talks are continuing.

AGN Scientists Seek Man-in-Space Answers

San Ramon, Calif.—Scientists at aerojet-General Corp.'s Nucleonics subsidiary are convinced it is possible to build a protective capsule to take man safely through the bands of radiation into space.

Protection against natural and man-made radiation hazards is one of the space radiation research staff's main projects.

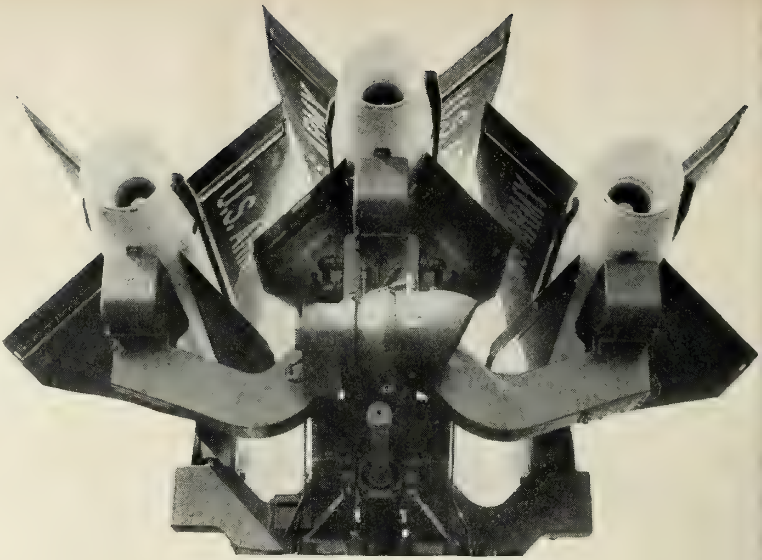
Dr. Robert P. Geckler, AGN biologist, said that bone marrow injections may be used to counteract the effects of low level radiation. Radiation protective suits have been discounted as too cumbersive and restrictive.

Scientists at Nucleonics are hopeful that the first successful lunar probe may reveal a minimum zone of radiation with comparatively radiation-free escape paths. They also feel that some day man will find a way to utilize the energy of the radiation belt's charged particles.

Most of AGN's work is channeled into the production of the Poly Pool educational and research reactor—a miniature version of the bulk shielding reactor at the Oak Ridge National Laboratory.

Missiles . . .
Men . . .
Production . . .

m/r staff photos



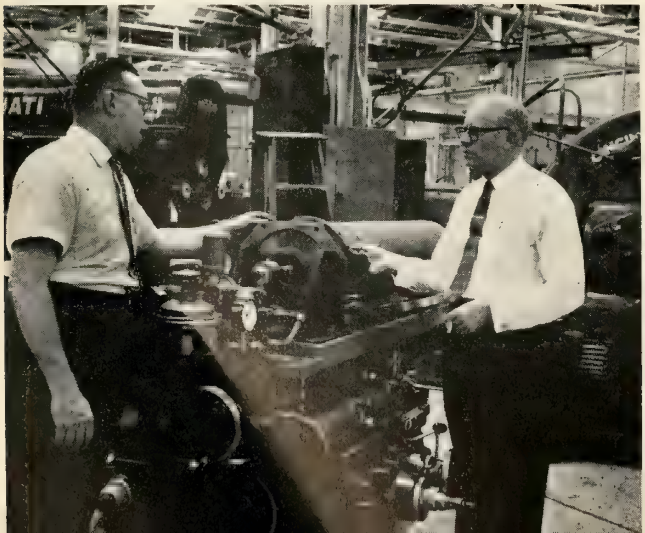
This unusual rear-view shot of Raytheon's *Hawks* shows details of tri-mount launcher.

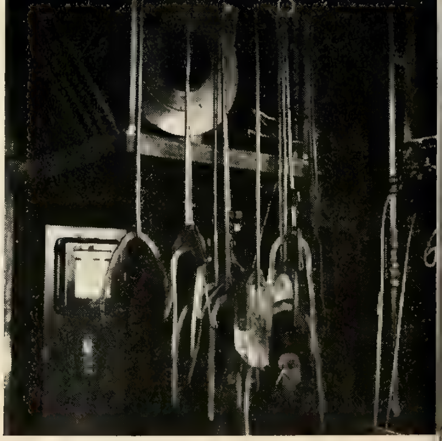
Judging from the intense looks, neither a salesman nor a buyer . . .

needs a lengthly caption to explain what is going on . . .

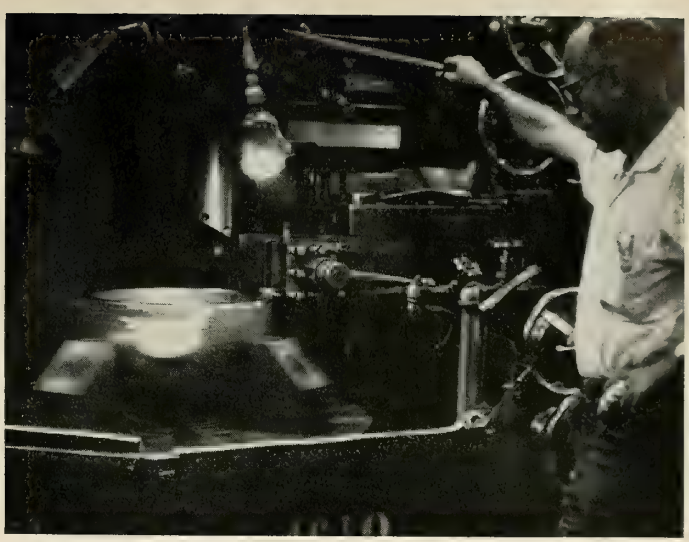
. . . in the above true-to-life picture sequence.

This specially designed tool uses hydraulic pressure between mandrel (shown) and *Terrier* solid rocket motor casing to hold piece rigid while detailed cuts are being made. This is part of a brand-new *Terrier* motor casing production plant built at Cameron Iron Work's Houston facility.



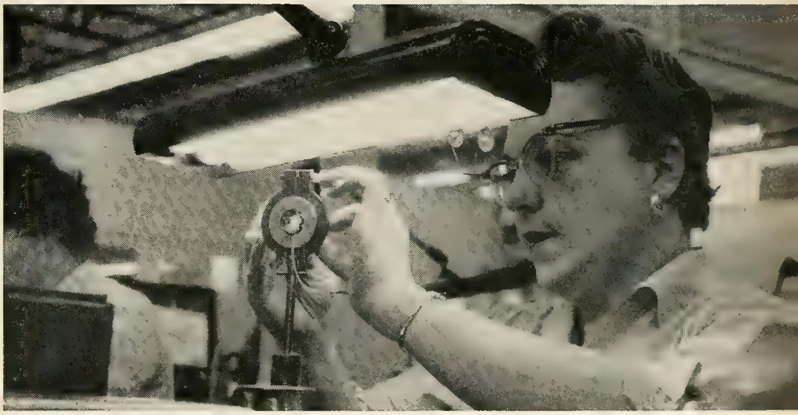


It may be a new business, but very often old tools do the job best. These tongs were made by a blacksmith at the Ladish Co.'s Milwaukee facility.



The forging for a jetavator for a modern missile receives its first machining cuts. Unusual shape is used in a solid propellant motor.

Missiles take big parts and little ones. Detail work is being done on the heart of a miniature rate control gyro.



Magnifying glasses and surgical cleanliness are required in assembling precision gyroscope assemblies at Detroit Controls division of American Standard Corp.

Peace and quiet is required in some missile work. Here, creep and yield test machines measure lives of different materials under various environments.

Machine tool precision work is required. Here, at Diversey Engineering Co., a nose cone mold is given final finish machining before shipment.

Head of Ordnance Missile Command Tells . . .

How Army Insures Missile Reliability

In this article, especially written for m/r, Gen. Medaris—Commanding General of the Army's Ordnance Missile Command—has undertaken to outline for readers the extreme care, and reasons for care taken by the Army to insure proper design and functioning of what have proved to be some of the nation's most reliable missiles.

Reliability—the positive assurance that the weapon will function effectively whenever required is the keystone of the Army's rocket and missile program.

The Army demands that reliability be achieved during the research and development phase of each weapon system, through a vigorous program of design, test and analysis. It is maintained during the production phase by a stringent quality assurance and quality control program.

The objective is to assure that existing and future weapons systems continuously perform their intended functions in the natural and induced environments in which they must operate.

Within each major element of the Army Ordnance Missile Command there is a group responsible for a reliability program for each research and development project. These programs are tailored to specific requirements. All are regularly monitored to insure adherence to Command policy.

A staff element is assigned this responsibility and also evaluates policy to determine that it is consistent with the most advanced state of the art of rocket development.

• **Considerations**—Five basic considerations enter into all reliability programs in the Command:

1. Definition of the reliability objective in each case.
2. Determination of total environmental conditions and design parameters throughout the life of the weapon system.
3. An intensive laboratory testing program and a companion flight test program to determine modes of failure, level of failure and test-to-failure.
4. Comparison of reliability test results to determine that adequate safety margins exist in the design, to insure that the probabilities are biased in favor of the system.
5. Establish quality assurance procedures which will insure conformity to the inherent reliability designed into the system.

• **Results**—The enhanced reliability of various Army-developed missile systems demonstrates improved reliability design. An outstanding example is the *Redstone* Ballistic Missile System. Here a high degree of reliability was inherent in the research and development and production phases.

The system's reliability has been demonstrated under semi-arctic and semi-desert conditions, and most convincingly by the tactical firings conducted by the 40th Field Artillery Missile Group (Heavy)—the first launchings of a large ballistic missile by U.S. troops.

In the *Jupiter* Intermediate Range Ballistic Missile System, being developed for operational employment by the Air Force, a Noteworthy degree of joint Army-contractor participation has been achieved in the resolution of reliability problems.

Perhaps the most striking evidence of this success has been the two recoveries of full-scale *Jupiter* nose cones with the assistance of the U.S. Navy. The recoveries established that *Jupiter's* inertial guidance system can deliver a warhead accurately to its target over the approximate full range of the weapon, and that the Army can protect the warhead from the aerodynamic heating encountered by an object reentering earth's atmosphere.

• **Cone recovery story**—Behind the headlines reporting the nose-cone recoveries is an efficiently organized research and development project in which the reliability philosophy has been carefully integrated.

Analysis, studies and test of aerodynamic stresses, structural designs and material composition guided the selection process. Finally prototype nose cones were developed and tested, first in wind tunnels to measure aerodynamic stability and then in the path of rocket engine jets to measure resistance to excessive temperatures.

Because of advances in reliability planning, programming and engineering, and the proper balance of laboratory and flight testing, the *Jupiter* System is expected to surpass *Redstone* in reliable performance.

How exhaustive the flight testing has been may be gauged from the average of 230 individual measurements obtained in flight on each test *Redstone*. Approximately the same number is derived from each *Jupiter* test launching. Each of the measurements is related to specific areas of investigation required by the missions of the individual missiles.

Maj. Gen. J. B. Medaris

Another example of Army-industry cooperation in reliability concerns the *Nike-Ajax* surface-to-air system. A quality assurance program was initiated in mid-1953 under Army Ordnance Auspices with the Bell Telephone Laboratories. This provided for a series of product evaluations, quality surveys and implementation of standard quality assurance procedures. An overall increase in system reliability of 12% was achieved. Better producibility as well as enhanced reliability resulted.

• **How it's done**—A continuing process of evaluation, review, analysis and corrective action is carried on. As a part of this standardization, programs seek to increase the use of interchangeable parts among the various systems. An important element in determining the need for an incorporation of design changes is extensive use of electronic data processing.

Product Improvement Committees made up of members of Army-Industry missile system teams, and representatives of the combat arms which use the weapons coordinate the review and analysis effort. Their recommendations go to the mission agency responsible for final action.

Ordnance Evaluation Laboratory facilities have been provided in the major elements of the Command to provide more effective control of prime contractors in the reliability effort. These laboratories verify design parameters, monitor contractor reliability achievements by means of independent testing, and contribute to advancing the state of the art.

An engineering concept review is conducted within six months after initiation of the project. Then the design agency presents to all interested elements, including the user, the military characteristics of the weapon design schedule industrial plan, field support plan, and training plan.

Design engineering review is conducted as soon as basic design decisions have determined the physical characteristics of the system and detailed design of hardware is underway. Mockups and some hardware are employed to explain the status of design to interested elements, and future planning is outlined. This makes possible early initiation of industrial and maintenance engineering and instructor training.

Engineering design inspection takes place when the design is far advanced and industrial engineering is proceeding on the overall system. Development-type hardware is employed as test prototype. The design agency portrays the status of industrial engineering and the supply and training agencies report their progress. Engineer user test schedules are discussed.

Production design inspection is scheduled when industrial engineering is well advanced and procurement is in progress. Now the complete system is demonstrated, utilizing the first production type hardware. No change in engineering design is acceptable, except as a result of the evaluation firings, and only when the change will effect significant improvement in the use of the system by troops. Any other desirable improvements are included after delivery of the first system of tactical design suitable for deployment.

The final review action, known as Special Coordinating Inspection, may be scheduled by the coordinating agency whenever it is considered necessary.

By introducing the reliability concept into every phase of the army's missile and rocket programs, we bring the weapon to the field confident that it will perform efficiently. Our constant purpose is to arm our troops with the best possible means by which to accomplish their objectives.

Explorer V In Ocean Grave?

By Norman L. Baker

As m/r went to press, the rate of the *Explorer* V satellite was still shrouded in mystery.

Speculation is that the satellite met the same fate as *Explorer* II, which fell into the ocean shortly after launching. All four stages of the *Jupiter*-C rocket carrier are reported to have fired without achieving the proper angle of launch. The brevity of the satellite's radio transmission, received at Fort Monmouth, indicates that the final stages fired in a nose-down attitude, with the satellite landing several hundred miles from the Cape Canaveral launching site.

Explorer V, originally scheduled for flight at 2:30 A.M. on August 21, but delayed for three days due to a faulty valve, was designed to supplement the experiments of *Explorer* IV. The time of launch was calculated to put the satellite in orbit on the opposite side of the earth from *Explorer* IV.

Assigned to obtain additional data on the corpuscular radiation belt, the opposed positions of the two satellites would have furnished simultaneous readings and would have recorded any changes in intensity levels.

Explorer V was one-half pound heavier than IV as the result of heavier shielding for the counters. *Explorer* IV has one of its counters shielded by lead one-sixteenth of an inch thick, while *Explorer* V, with similar instrumentation, was equipped with shielding 3/16 or an inch in thickness.

According to Brig. Gen. John Barclay, commander of ABMA, *Explorer* V would have attempted to determine the nature of the radiation—whether the particles are electrons or protons.

If the particles of the belt are electrons, the highest intensity recorded would be about ten roentgens an hour. If the particles are protons, this intensity would be about 100 roentgens an hour. (AEC has recommended 0.3 roentgens per week as a maximum safe human exposure.)

As a result of *Explorer* IV measurements, it is now known that from 250 miles to the satellite's apogee of 1,300 miles, the intensity level of the belt doubles every 60 miles. At the apogee, the intensity is so high that no difference was recorded in the readings of the shielded and unshielded counters.

• **Radiation belt**—Prof. Fred Singer, at the 9th Annual Congress of the International Astronautical Federation held last week in Amsterdam, (see p. 10), advanced the theory that the particles in the radiation belt were protons. This reasoning is based on the fact that when primary cosmic rays smash into the earth's atmosphere and disintegrate the atmospheric Nucleus, most of the neutrons released travel upward and out of the earth's magnetic field in straight lines.

Some of these neutrons, when traveling through the magnetic field, change into protons and immediately begin to spiral around the magnetic lines of force. Singer stated that the lifetime of the protons is so long that the trapped particles start concentrating at 600 miles.

The lifetime of the particles is inversely related to the density of the atmosphere. Therefore the decrease in density with an increase in altitude increases the lifetime of the particles. Singer theorizes that a maximum concentration is reached at the equator at about 1½ earth radius, or 6,000 miles, where the intensity drops.

At about 10 earth radius, he believes the radiation belt ends gradually. The intensity is known to decrease with higher latitudes, with a complete absence at the poles.

• **Answers**—Singer proposed three possible solutions to radiation hazard:

A vehicle could be equipped with a "shadow" shielding ring. Based on the theory that trapped particles spiral mainly at right angles to the line of force, and are therefore incident mainly perpendicular to the line of force, the ring would be sufficient for trapping the particles.

Another method, based on the fact that the incident radiation is in the direction perpendicular to the line of force, would employ a coil positioned around the space station with its axis parallel to the line of force. The coil would create a small-scale dipole field, providing a magnetic screen that would turn away the radiation bombardment.

The most novel proposal suggested the use of "sweeper" satellites for cleaning a channel in the radiation belt. The satellites moving through the belt would absorb the protons, reducing the intensity to tolerable limits. This method would require several satellites having a large cross-sectional area.

Prof. Singer's proposals are significant in light of the shielding requirements for a brute force approach to travel through the radiation belt. To reduce the energy of the trapped protons to 10% would require a shell about 4 cm thick. To protect a sphere 12 feet in diameter would require over 10,000 lbs. of lead.

missile business

The growing trend toward team bidding for missile work—flagged in these columns months ago—gets a strong boost from Air Force Maj. Gen. William T. Thurman, director of procurement and production for Wright-Patterson. A circular over Gen. Thurman's name asks trade associations in the aircraft, electronics and similar industries to bring team bidding procedures to the attention of their members.

An old story in some other fields—particularly construction, where contractor "joint ventures" have ranged to such mammoth ventures as Hoover Dam and the St. Lawrence Seaway—the concept of a team operation is a simple one: A group of firms put their special capabilities together to produce a single product more efficiently and economically than any individual company could possibly do it. In missile production, where so many highly specialized pieces must be conceived, manufactured and put together, the concept is particularly valuable, thinks the Air Force.

Biggest problem in team operation—once the contract is awarded—is in management. Automatically, there are a lot of potential bosses in such a combine. The solution, says Air Force, is a special management group set up specifically to handle the joint contract, keep down paperwork, keep up vital communications, generally ramrod the job. A management advisory board, chaired by an officer of the team leader, is usually the first step, backed by necessary staff.

Air Force has also gone to some pains to reassure industry that the service won't pay for duplicate facilities or build its own, so long as it knows that sufficient capacity exists. "Air Force funding (for industrial facility expansions) will be resorted to only when private capital is unavailable . . . and program needs make government funding absolutely necessary," says AF's latest INDUSTRIAL NEWSLETTER.

Additionally, AF sets up guidelines for contractors on management of their in-plant and subcontract dollars: (1) Procurement orders or re-orders involving government-owned facilities will be screened to insure that items requiring government facilities can't be obtained through private sources; (2) "make-or-buy" studies will be reviewed to assure maximum use of the defense industry's subcontract capability; (3) new facilities expenditures will be authorized only on an absolute minimum basis, in areas beyond research and development and pilot production; (4) existing AF industrial facilities will be disposed of wherever possible.

The general business upturn—reflected in almost all barometers, both private and government—hasn't gone far enough yet to encourage real inflation-making moves in the way of drastic price rises, demands for big jumps in labor's pay, etc. But some Congressmen have already raised the cry of inflation and controls (witness Sen. Kefauver's threat to investigate the steel price increase). The Federal Reserve's move to raise the rediscount rate (in the San Francisco area, for one), is evidence that federal money managers are ready with moves to head off a too rapid rise.

The "Fed" is taking a cautious view of the upturn however, pointing out that similar early strengthening of the economy was followed by mild reversals in 1949 and 1954.

Certainly, the midyear financial reports in the past several weeks have shown a spotty picture for firms with heavy missile interests. Last week's crop, for instance, showed this picture: **Curtiss-Wright Corp.** said its second quarter consolidated net profit was $10.9 million for 1958, compared to $20.7 million a year ago; **Zero Mfg. Co.** reported a record first fiscal quarter, with sales of $797,517, compared to $675,536 a year ago.

contract awards

LAST MINUTE AWARDS

Boeing Airplane Co. gave **Tele-Dynamics Inc.** a substantial contract to design, develop, and manufacture a telemetry system for use in the operational flight testing of the *Bomarc* ground-to-air missile.

Digitron, Inc. announced the receipt of a contract to develop a high-speed electronic function plotter for Holloman Air Development Center.

The Computer Div. of Bendix Aviation Corp. was awarded a contract for the electronic computing unit of the missile impact prediction system at Cooke AFB, California.

Symington Wayne Corporation of Salisbury, Maryland and Fort Wayne, Indiana, manufacturers of gasoline pumps, hydraulic lifts, air compressors and industrial and defense products, has been awarded a government contract for slightly in excess of $1,600,000 for production of hydraulic launching equipment for the *Nike-Hercules* missile.

Zero Manufacturing Co., Burbank, California, received a contract for development of a re-usable aluminum modular packaging system for transport and storage of Naval ordnance, such as missiles and missile systems.

Allen B. DuMont Laboratories, Inc., received a contract from the Navy for developing test equipment for single side-band transmitters.

AIR FORCE

By HQ, AFOSR, ARDC:

Columbia University, New York, N.Y., received $27,839 for research on "dynamic behavior of flat plates and shells."

Cornell University, Ithaca, N.Y., received $92,960 for continuation of research "probability theory and analysis."

University of Southern California, Los Angeles, Calif., received $152,241 for continuation of research "rarefied gas-dynamics."

Brown University, Providence, R.I., received $26,000 for continuation of research on "heat transfer from surfaces on non-uniform temperature distributions."

By Ogden Air Materiel Area:

Thiokol Chemical Corp., Elkton, Md., received $26,840 for igniter M-41, for rocket motors M-58 solid propellant.

By HQ, AFMTC, ARDC:

General Dynamics Corp., Convair Div., San Diego, Calif., received $533,000 for increase of funds.

Telemeter Magnetics, Inc., Los Angeles, Calif. received $25,293 for increase of funds.

Motorola, Inc., Western Military Electronics Center, Phoenix, Arizona, received $183,244 for increase in funds.

NAVY

By District Public Works Office, Ninth Naval District:

Wm. E. Schweitzer & Co., Evanston, Ill., received $104,000 for foundations and power supply for MK-10 missile launcher at the U.S. Naval Training Center, Great Lakes, Ill.

ARMY

By Engineer District, Chicago, Corps of Engineers:

Bregman Construction Corp., Chicago, Ill., received $1,617,000 for construction of ICBM/IRBM training facilities at Chanute AFB.

By New York Ordnance District:

Belock Instruments Corp., Long Is-and, N.Y., received $439,711 for design, engineering and fabrication necessary for development of prototype components required in a scheduled miniaturization program for reduction in size and weight of missile components.

By Ordnance District, Los Angeles:

Douglas Aircraft Co., Inc., Santa Monica, Calif., received $139,405 for blue streak & emergency repair parts for *Nike* system.

Courtland Lab., Los Angeles, Calif., received $35,390 for starting mixture.

Douglas Aircraft Inc. received $24,004,157 for *Nike-Hercules* launching area tems.

Grand Central Rocket Corp., Red-ands, Calif., received $36,094 for *Dart*, rocket motors and igniters.

By HQ Quartermaster Res. & Eng. Command:

Magnesium Products of Milwaukee, Milwaukee 4, Wis., received $215,155 for 4 shelters, frame type, missile storage 0 ft., with dehumidification liner.

By Boston Ordnance District:

Smithsonian Institute, Washington, D.C., received $225,637 for satellite tracking program.

Raytheon Mfg. Co., Waltham, Mass., eceived $745,624 for repair parts for *Hawk* missile.

west coast industry

by Fred S. Hunter

In excess of $50 million in tax money is at stake in a hearing on the calendar of the California supreme court this fall. This is the accumulation of property tax payments made by defense contractors and held in escrow pending settlement of the litigation over legality of the tax. In dispute are "possessory interests" in government owned materials and work in process. A lower court ruled in favor of the industry in 1957 on two test suits filed jointly by Aerojet-General Corp. and the Pomona division of Convair. It is Los Angeles County's appeal from this decision that comes before the state high court in October.

Meanwhile, Los Angeles, San Diego and Alameda counties continue to impose these tax assessments on government materials against the manufacturing companies. Lockheed's total tax bill this year, for example, will add up to approximately $9.35 million. Of this, approximately $3.34 million will be protested as covering property not owned by Lockheed, but by the government. Another county, Ventura, decided not to wait for the supreme court's decision. North American Aviation will get a new tax bill this year on an assessment value of $1,946,960 for its "possessory interest" in government owned property at Rocketdyne's test facility in the Santa Susana Mountains.

Background of the local tax trouble is lack of a California law. In World War II, when aircraft and other defense work boomed, county officials were patriotic and agreed that government materials should not be taxed. But after the war, when the California population gain outran tax revenues, the counties found great need for the money. If the supreme court upholds the lower court's order, the counties will undoubtedly go to the legislature for a law. The defense industry may get a refund on the $50 million paid in, but the tax on missile and other defense materials will be back again just the same.

Proposal writers for the prime manufacturers are now at work preparing their bids for the biggest phase of the *Minuteman* program, the contract for assembly and test of the solid propellant ballistic missile. By prime manufacturers, we mean not only the large airframe companies, including all six on the West coast (Boeing, Convair, Douglas, Lockheed, North American and Northrop), but such companies as Bendix, Curtiss-Wright, General Electric and the big three of the automotive industry; Chrysler, Ford and General Motors. These are the companies which recently received invitations to bid from the Air Force Ballistic Missile Division. The contract may be let by Nov. 1, possibly before, if expedited. The company that wins gets the plum of the year.

The financial agreement Summers Gyroscope Co. stockholders approved with Atlas Corp. provides the Santa Monica concern with needed working capital, and at the same time strengthens the management. It brings in Jack S. Warshaur, formerly with an Atlas affiliate, Mercast Corp., as executive vice president and chief executive officer. President Tom Summers, Jr., an inventive genius, is left free to devote himself to product activity. At first, there were plans to merge Summers with Mercast, but these were dropped in favor of a loan agreement under which Atlas has an option to acquire controlling stock in the company.

Big Blasts—North American has its Rocketdyne division at work developing a thrust chamber to provide a backup unit for Reaction Motors rocket engine, scheduled for the X-15 rocket-powered research craft. Judging from reports of the way Rocketdyne has been rocking the hills in Santa Susanna, it must be making progress in its experimentations with new liquid fuels. They are said to have four times the thrust of old fuels.

Business Good at Wescon Show; Recession Called Industry Aid

Los Angeles—Optimism was the theme of the 1958 WESCON meeting here in Los Angeles.

This feeling was expressed over coffee breaks between the well-attended technical sessions, and in snatches of conversation in the crowded display aisles of the 900-odd exhibits at the city's Pan-Pacific Auditorium.

The booths of various commercial firms were less ornate than in some past shows, but more purposeful. Many of the displays used missile themes as eye-catchers.

Some exhibitors said that more off-the-shelf sales were made this year than at any previous show.

One fairly typical example was Non-Linear Systems, Inc., which brought along 10 of its newly announced $985 digital voltmeters just in case some purchaser might want "immediate delivery." When the show closed after a four-day run, the company had sold four with purchasers in Los Angeles, and more were on their way to receiving rooms of show visitors from other points.

"We've been fighting off potential exhibitors," declared Bruce S. Angwin of General Electric, and WESCON executive committee chairman. But he noted that if more space had been available, the show might have reached a saturation point as far as displays were concerned.

Angwin was not sure why this year's show elicited such a great commercial response, but said he believed two main factors were involved—a return to the "hard sell," and the possibility that the electronic industry of the West Coast had not suffered as greatly as some other areas of the U.S. in the past 18 months.

Complimented on the high quality of technical papers, Angwin said that the high level technical committee which selected the topics had insisted on quality if it meant "reducing the entire meeting to one paper."

West Coast Grows—An additional reason for the show's wide interest is probably the fact that the West Coast electronic industry is principally concerned with research and development, rather than high production hardware, Angwin pointed out. This is particularly true in the missile and space vehicle field, in which the West Coast leads the balance of the nation.

There are no figures at the moment as to what percentage of area's electronic industry is engaged in missile work, but some statistics are being compiled for the future. The West Coast is presently undergoing the development of production capabilities in a "greatly accelerating curve," as Angwin puts it. Some is local expansion, the rest an extension program of many old-line mid-West and East Coast firms in the building of new facilities on the West Coast or the acquisition of West Coast companies.

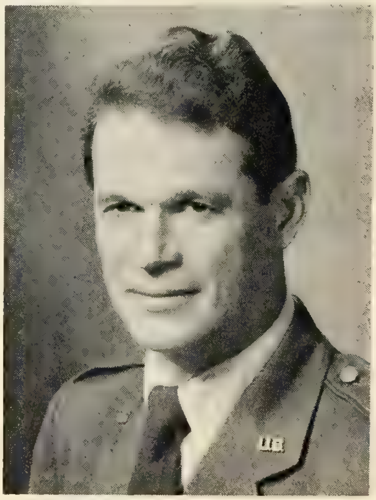
Another source of optimism is Donald S. Duncan, president of the co-sponsoring West Coast Electronic Manufacturers Assn., and vice-president, general-manager, Beckman/Helipot Corp.

Duncan believes that the West Coast electronic industry has, since the first of the year, boosted itself back to the financial peak of about 18 months ago.

"The so-called slowdown has been the best thing that happened to many companies," he said. "It taught them how to chop overhead, reorganize, and in general become a better company."

There appears to be little increase in the amount of companies willing to carry programs on their own. Postwar concerns which stayed clear of government contract and put about 12% to 15% of their own funds back into research and development work, could not carry these programs when production items dropped off. But Duncan believes that production volume will increase in the future as will research and development, but the latter will increase at a slower rate.

Joins Staff



F. CLARKE NEWLON today assumes the post of Executive Editor of MISSILES and ROCKETS magazine, succeeding Erik B. Bergaust, who becomes Editor. Mr. Newlon recently retired as Assistant to the Director, OIS, USAF.

Recession Helped—WCEMA, Donald E. Root, vice-president and administrative manager of the Cubic Corp., also belongs to the school that believes the recession was a good thing—"it forced good management," he says.

Companies that struggled to carry their research and development capabilities with out-of-the-pocket funds, now find themselves in an excellent position. This is shown that in spite of the high rate of failure on the part of marginal operators, the West Coast area surpasses any other in growth.

But, Root poses another thought that is interesting—an area in which he believes more thought should be given, especially by smaller firms.

Pointing out that about 80% of new products fail economically, he says that the West Coast electronic industry is engineer-oriented. This is extremely valuable in military areas where the final product is not a mass product. The West Coast will eventually reach high production rates, he notes, but one of the biggest problems at present is marketing.

Electronics Group Hails Calibration Center Opening

The electronics industry depends heavily on accurate measurement and standardization techniques for missile and space exploration phases of the industry's development.

Robert C. Sprague, board chairman of Sprague Electric Co., told an audience of scientists and engineers at the new Electronics Calibration Center at Boulder, Colo., that the NBS program on standards for electronics "is generally advancing on a broad technical front." But he added that further attention is needed to support the mushrooming, highly technical electronics industry.

Commenting on the importance of the Calibration Center, Sprague said, "Today's long-range radar and missile guidance equipment could not possibly achieve the high degree of accuracy required of them by our military services if we did not have such reliable measurement services as are now available in the new Center and the Washington Laboratories of the Bureau."

Sprague commented that today's military electronics production accounts for more than half of the industry's dollar volume.

Heat Control Toughest Manned Flight Job

SAN DIEGO—Ignorance of space-heat relationships has made temperature control the number one problem in providing an artificial environment for manned space vehicles.

More data on the magnitude and nature of solar loads on a stabilized orbital vehicle must be gathered before intelligent decisions can be made. Lacking other data, it may be assumed that heat loss will be a major part of the problem, and man himself may prove to be the best heat source in an artificial environment.

These thoughts were expressed in a paper by Air Force Lt. B. Pinc, Bio-Astronautics Section, ARDC, presented to a recent joint ARDC/IAS/ARS regional meeting on "Space Exploration" in San Diego, Calif.

For orbital flights of short duration, environmental systems will be essentially identical to these in current high-performance aircraft. A high pressure gas, reduced and metered on demand to a full pressure suit and vented overboard, will supply an "atmosphere." Temperature control will be handled by a ventilation garment and a circulating fan system. Simple inflight or survival rations will take care of food requirements. Waste management will be achieved by pre-flight diet, pharmaceutic control or simple stowage.

Many of these devices or systems are not practical for longer flights with limited weight-volume-time parameters. The future approach must consider some sort of a re-cycling system, or in the ultimate form, a true closed ecology.

Lt. Pinc defined such a system as "a complex of mechanical, inorganic and organic subassemblies which independently maintain a principal inhabitant in a state of psycho-physiological homeostasis and permit useful operant performance." These ends must be achieved with negligible system constituent loss, maximum waste recovery and conversion, low weight, extremely high reliability and a high time-over-energy ratio, he added.

• **How about food?**—Included in the environment is a nutrient sub-cycle to provide devices for the storage, preparation and ingestion of nutrients such as calories, bulk, vitamins, fats, carbohydrates, proteins, metals and water in the proper amounts. This cycle also incorporates solid and liquid waste recovery, conversion, reconstitution and reconstruction into food of tolerable acceptability and palatability.

There has been considerable work in this area, mainly slanted towards biological waste conversion, reconstruction and reconstitution. However, at the present laboratory bench level, these approaches require relatively huge amounts of power, weight and volume. The answer does not point to miniaturization, compaction and high-yield formulations. Such steps can be taken only after basic feasibility has been demonstrated. Present work in reconstitution and reconstruction of wastes is still based on conjectural biochemistry.

The AF officer suggested that the use of common green algae, as has been proposed, is not the way out. The algae is deficient in many aspects as a nutrient. He also suggested that an ancillary amino acid cycle might be employed using either bio-synthetic or physiochemical synthetic means, or else an extremely efficient waste recovery system must be envisioned.

• **Work and rest**—A second sub-cycle, designated the psycho-operant sub-cycle, is required to provide good work and rest area equipment and physical layout of the vehicle's interior. Designed to assure job performance and job satisfaction, the sub-cycle would provide opportunities for rest diversion, physic support and sleep—all necessary to help control fear and aid in motivations and control.

Work must be done on the problem of decoding what functions can be relegated to or performed by man, and then designing instruments to let him perform the job.

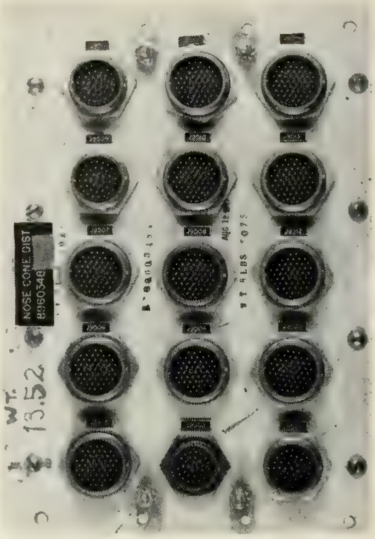
The third sub-cycle is that of ambient environment to measure, purify, pressurize and supply or control, within close tolerances, all constituents of the gaseous environment. The system must also measure and control the total heat balance of the microecology. This is the most difficult system of all and the most seriously needed. The other two sub-cycles or systems are not really needed until very ambitious flights are planned.

• **Air control**—For the control of carbon dioxide, Lt. Pinc ventured four methods: (1) scrubbing with chemical absorbents; (2) photo-synthetic reduction which seems to have the same problems as the use of green algae; (3) physiochemical which requires too much energy; and (4) a method that is hypothetical at present, but considers an extra atmospheric heat sink as a cold source to achieve gas freezeout and the use of solar heat for selective gas vaporization. Lt. Pinc pointed out in conclusion that the heat sink approach might also be used in humidity control.

Begin X-15 Engine Testing

READY TO BEGIN static testing of the *Pioneer* rocket engine for the X-15 research aircraft is this new concrete and steel test stand built by Reaction Motors division of Thiokol Chemical Corp. The sloping tank (at left) is one of two propellant tanks which are an integral part of the stand. The large tank (background) is the division's 150,000 gallon water tank which supplies the entire test area.

Instruments Survive Re-entry



TAKEN SHORTLY AFTER A *Jupiter* full-scale nose cone was recovered, this view shows the 15 miniaturized connectors which act as major cable inlets to various components necessary for functioning of re-entry equipment.

HUNTSVILLE—Instrumentation carried in the full-scale *Jupiter* IRBM nose cones, recovered May 18 and July 17 after successful launchings, (m/r July 14, p. 14) came through the gruelling test entirely undamaged, and could be used for another launching, m/r has learned.

This could also mean that proximity fuzing, active or passive homing devices, and circuitry would not be affected by re-entry, thus making possible less critical accuracy requirements for homing equipment during the missile's flight. Combined with a multi-megaton warhead, this could bring the nation much closer to operational IRBM and ICBMs.

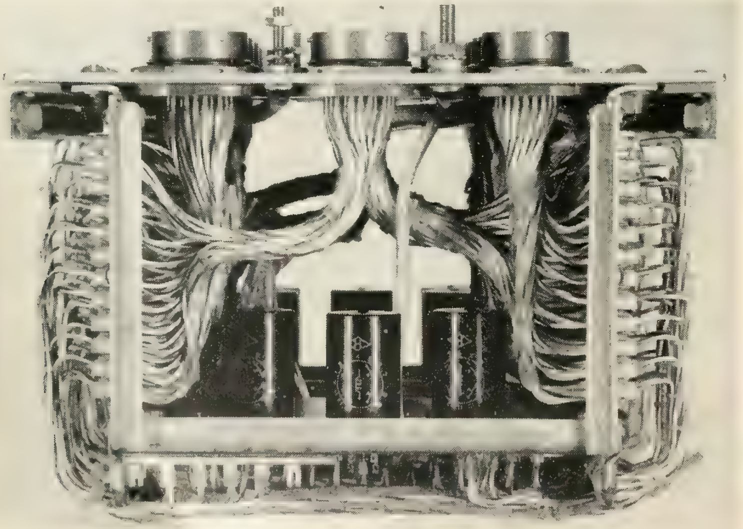
The "nerve center" of the nose cone functioned perfectly, the Army said, in spite of tremendous forces of vibration, acceleration, aerodynamic heating and velocities of more than 9,000 mph.

It was the second time that such electrical instrumentation has been carried into outer space and recovered for evaluation. Connectors were opened and solder connections visually inspected. Inspection of the wiring installation disclosed no damage to harness insulation lacing cord, rubber clamps or cables positioned next to the skin.

The distributor system was designed by the Guidance and Control Laboratory of ABMA, under direction of Dr. Walter Haeussermann. It was built by ABMA's Fabrication Laboratory, headed by Hans H. Maus. Prior to launching, the system underwent acceleration and functional performance testing in the Systems Analysis and Reliability Laboratory directed by Erich W. Neubert.

Albin E. Whittmann, chief of electrical systems analysis, credited good workmanship, rigid inspection and "know how" for the successful nose cone test.

"If man is to go into outer space and return safely," remarked Whittmann, "he can have nothing but the best in missile components and instrumentation."



U.S. Army photos

THE NOSE CONE DISTRIBUTOR (side view) flown in the full-scale *Jupiter* nose cone re-entry test. Three of the eight relays, which control electrical functions by remote control, are visible (center). Not even solder connections were damaged. Manufactured by the Hart Mfg. Co., the relays were functionally tested prior to flight.

High-Temperature Plastics Promising For Missiles

What may prove to be a major breakthrough in materials for missile nose cones has been announced by Taylor Fibre Co., Norristown, Pa., as a result of research in composite laminated plastics carried on during the past several years.

The company refuses to assert categorically that the new material is the best for nose cones, until tests have been made under conditions which parallel those encountered by missiles during re-entry into the atmosphere. However, tests indicate that the composite laminate plastic holds great promise.

The tests showed that in five minutes (which exceeds the maximum time a missile is subject to atmospheric friction on re-entry), the composite material conducts about 25% less heat from the surface to the interior than the most effective homogenous material tested. Surface temperature was 2,000 degrees F.—about the same as that generated by missile re-entry.

Navy Lets Contracts For Two Fleet Ballistic Subs

Two fleet ballistic missile submarines will be built in the Navy's fiscal 1959 shipbuilding and conversion program, it was announced by the Navy. One each will be constructed by the Portsmouth Naval Shipyard, Portsmouth, N.H., and the Newport News Shipbuilding and Drydock Co., Newport News, Va.

These submarines, designed specifically to carry and launch *Polaris* missiles, will be similar to three ballistic missile submarines now under construction.

Japan Taking Delivery Of Swiss Oerlikon Missiles

The Japanese Defense Ministry is taking delivery of Oerlikon 56 surface-to-air missiles this month.

The Swiss missiles represent the first surface-to-air missiles purchased by Japan from any foreign power. Initial shipment will consist of one launcher and ten missiles.

Test firings are not expected to start until next February, and will be designed to obtain information on the producibility of the missile by Japanese plants.

world astronautics

by Frederick C. Durant III

If you want to go college to study astronautics, where would you go? Of course, CalTech, M.I.T., Princeton, Purdue, State Univ. of Iowa and a few other names may come to mind. But what other schools offer courses you would require? The American Rocket Society (ARS) is finding out for you.

The Technical and Educational Subcommittee of the Space Flight Technical Division recognized the need for a survey of all U.S. institutes of higher learning. M.I.T. Prof. Paul Sandorff (who conducts an Orbital Vehicles course) prepared the questionnaire. A preliminary report by Sandorff indicates that 104 replies (out of 189) have been received. Sixty percent of those responding "offer or plan to offer courses in fields of study related to space flight"; while 44% "offer research opportunities" in these fields. Very heartening indeed! The published final report should be most interesting.

The international value of the oblateness of the earth is being found in error, according to preliminary analysis by the Army Map Service. H. G. Hertz and M. Marchant have calculated the value from NRL data on 1958β. They obtain an oblateness value of $1/298.38 \pm 0.07$ which is considerably smaller than the widely accepted value of 1/297.0. Calculations based on 1958γ yield $1/298.0 \pm 0.3$.

German moonwatch teams have been organized during the past six months and a number of radio tracking stations have been set up. Among the professional groups participating are the Max Planck Institute for Aeronomy at Lindau and Weissenau, the Technical University of Munich and the Astronomical Observatory of the University of Bonn. The Federal Ministry of Posts in Darmstadt serves as data-collection and communication center.

At a meeting this spring, H. K. Paetzold of Max Planck Institute presented some findings from analysis of the extensive records of 20 and 40 mc. emmissions of *Sputnik* I and II. One anomaly observed was reception of the signals "suddenly and with high intensity when the satellite was still far below the visual horizon." A conclusion reached was that the ionosphere itself acts as a conductor of radio waves. Much higher temperatures (1000°K at 200 Km.) at high altitudes have been concluded also. The reason for these higher temperatures is believed to be related to exchange reactions between stratospheric and interplanetary hydrogen and helium.

Another observation is that the braking effects of the atmosphere on the satellite are apparently not due solely to a higher density of the exosphere as such. It is believed "that they are also produced to a very appreciable extent by the satellite becoming electrostatically charged in its orbit. This then leads to the formation of a cloud of ions surrounding the satellite and tending to increase its virtual diameter with respect to the braking action of the stagnant parts of the exosphere."

Notes from all over—The ARS expects to welcome its 10,000th member before the end of the year . . . Dr. T. E. Sterne of Harvard Observatory has developed a simple and useful formula for inferring atmospheric density from earth satellite data. Bessel functions are used . . . June issue of RUIMTEVAART, bimonthly publication of the Netherlands space flight society, carries an interesting article (in English) on design and use of satellite optical observation equipment, by K. A. Thernoe . . . Helmut Gröttrup, former leader of German rocket team in U.S.S.R. after WW-II, is on editorial staff of RAKETENTECHNIK UND RAUMFAHRTFORSCHUNG (R und R), technical journal of the German rocket and space flight society. Gröttrup now lives in Pforzheim, Germany . . . The possibility of a "cold fusion reactor" is discussed in the latest issue of R und R.

Gatling-gun Rockets Developed at Armour

The Mechanical Engineering Research Department of Armour Research Foundation currently has two gun-boosted rockets under development, the T-134 and the T-132. Both use the high firing rate Gatling-type gun.

The T-134E1 automatic rocket launcher is a powder-gas accelerated, multi-barrel weapon designed to fire the 2.75-inch boosted rocket, T-131. The weapon is capable of achieving firing rates well above those of currently-used similar models. Included in the launcher mechanism is a powder-gas operated brake, which will stop the launcher in case of a hangfire round and when burst firing is completed. The gun is light in weight. Design, fabrication, and development is for the Air Force, under an ordnance contract supervised by Rock Island Arsenal.

The 38-mm T-132 launcher is another Gatling-type weapon that automatically fires at high rates. The T-225 boosted rocket is continuously fed during firing. Experimental models have been successfully tested, and several prototype launchers are now incorporating accessory devices designed to achieve burst firing control. The program is an Air Force development and is conducted under sponsorship of Redstone Arsenal.

A program to design and install the T-132E2 rocket launcher in an F-89 aircraft is being conducted by Armour Research. Sponsorship is by the Air Force, Air Materiel Command. Technical supervision is under Air Force Armament Center, Eglin Field, Florida. The program includes development of the feeding, ejecting, and gas-purging subsystems. Preliminary firings have been conducted with the launcher installed in an F-89 nose section.

Army Indicates Interest In Solid Fuel Rockets

An indication of Army interest in solid fuel rocket motors was a recent visit of Dr. Wernher von Braun, the Army's missile expert in the liquid propellant field, to Aerojet-General Corporation's solid fuel development areas near Sacramento, California.

Von Braun spent several days at the A-G plants at Sacramento, and exhibited interest in the company's solid fuel rocket motor developed for the Navy's *Polaris* program.

The Army expert also expressed interest in the dual first stage liquid fuel engine now in production for the Air Force *Titan* ICBM.

Space Exploraton Plans Seen "Inadequate"

Present space exploration plans—based on extrapolation of the nation's current rocket capability—are falling far short of what is needed for long-range planning of astronautical research and development.

This is the opinion of astronautics project manager John DeNike, of the Advanced Design Department, Martin Company.

DeNike, who lead a Martin team in preparation of a moon-base study program that was published two weeks before *Sputnik* I was launched, believes that studies of bases—for the moon, Mars or Venus—without regard to the purpose of the base, will bring about a definition of objectives for the nation's astronautics program, and a means of defining the research and development programs to accomplish these objectives.

The researcher, now in the process of defining the moon's environment and subsystem design, points out that the U.S. has produced programs for space exploration at a rate which rivals TV "western" outputs. "Basing man in space is the real mission—of which but a small part is Mission X—whether Mission X is scientific, military or commercial," he said. Only with this can the required systems—rockets, guidance, airframe—be realized, he added.

• **Moon base studies**—Martin has completed the initial phase of a moon base study. The company assumed a six-step development of the lunar base: these steps were initial landings, site selection, build-up and construction, beneficial occupancy, initial operational capability and moon base expansion. Five men were chosen for each of the first two missions; an Aviation Engineering Battalion for the build-up; 230 men for the occupancy; and about 1,000 for the initial operational capability.

Expansion was not numbered. Martin found the selection of numbers of men not critical to the requirements in all but the initial phases. Initial material requirements ran 2.4 tons per man; resupply of material was 52 pounds per man per day, oxygen requirements were 10 cubic feet per man per hour; and water was 20 gallons per man per day. Constructional material was pegged at 10,000 tons, about half the tonnage required to build a medium bomber base. Time for construction was estimated to be from four to six months.

Martin is on the second part of the study defining the environment and subsystem design. Defining the lunar environment is an extremely difficult task, the company discovered. After defining gross features—size, shape, mass, physiography—there is a divergence of opinion.

However divergence is not affecting design work, for the subsystem is largely independent of the physical property. While in most cases it is possible to resolve the differences in the light of latest experimental findings or theoretical work, Martin is treating the unknown as parameters in design work.

Foreign Information Center To Process Soviet Data

The Office of Technical Services of the Department of Commerce has begun operation of a Foreign Technical Information Center to provide American science and industry with access to translations of a large amount of Soviet technical data.

The services of FTIC include publication of abstracts of all articles appearing in 141 Soviet technical journals, translations of important sections of REFERATIVNVY ZHURNAL (the Soviet Union's own abstract journal), and a semi-monthly review of various areas of Soviet science.

Abstracts of each issue of the 141 journals may be published from OTS on a subscription or single issue basis, as also the Central Intelligence Agency's SCIENTIFIC INFORMATION REPORT.

The volume of material collected and disseminated by OTS is estimated to run at 50,000 abstracts and 10,000 complete translations each year. Congress has appropriated more than half a million dollars for the operation of the technical information center in FY 1959.

Missile Company To Study Utility of Sub Cargo Ship

The utility and feasibility of an underwater cargo vessel is currently being investigated by Aerojet-General's Underwater Engine Division, under a working study contract with the U.S. Maritime Administration.

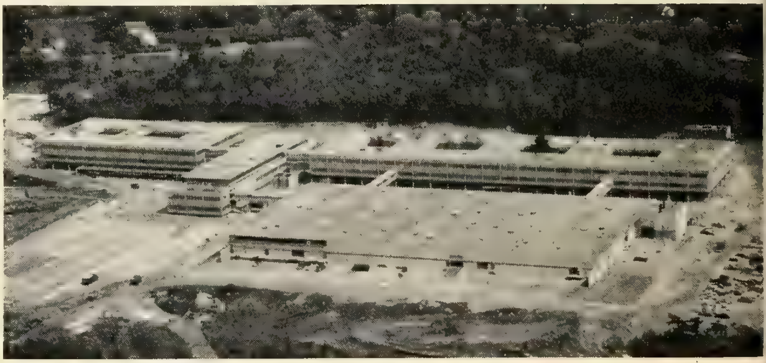
The six-months program includes both analytical and experimental hydrodynamic studies. These tests will serve as a basis for the preliminary design of a ship which, when underway, will be submerged with only a thin strut or fin piercing the water's surface. This fin will sustain an above-the-water gondola in which the navigating and living areas will be located.

Preliminary design of this high speed subsurface vessel is oriented toward commercial rather than military lines.

Douglas Gets $24 Million for *Nike* Base Conversion

Army Ordnance has awarded Douglas Aircraft a $24,004,157 contract for launch equipment units as an addition to an original $48 million contract authorized to convert *Nike-Ajax* sites to *Nike-Hercules.*

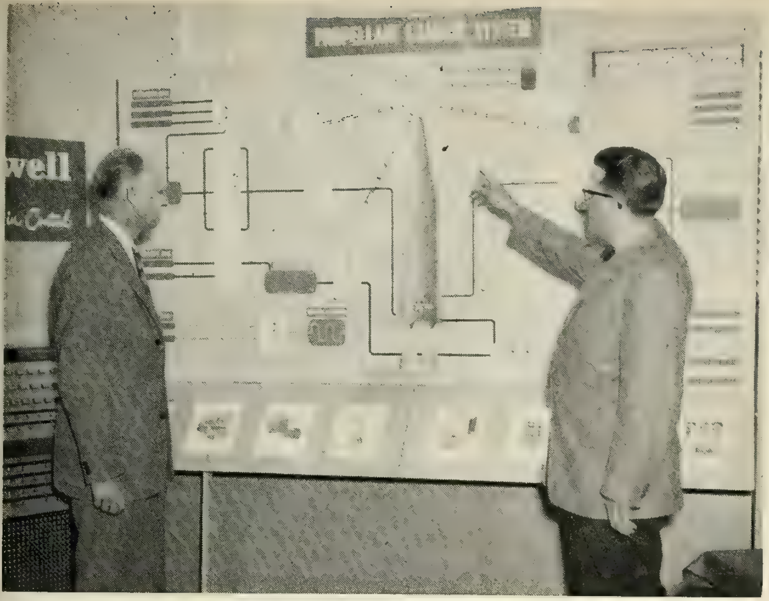
Avco Expands R&D Space



Avco's Research and Advanced Development Division recently began the first part of its move into the corporation's new $16 million facility at Wilmington, Mass. The Avco Research Laboratory, a separate division of the corporation, is scheduled to move into the new facility later in the fall.

Some Research and Advanced Development Division operations are already underway in Wilmington. Dr. Lloyd P. Smith, president of the division, said that with the exception of some units of the Electronics Systems Department (which will remain in Boston), all units are now in full operation.

The new complex, designed to provide Avco with permanent facilities for work in basic and applied science and engineering, will total 440,000 sq. ft. in four integrated buildings. Additional buildings of 8,000 sq. ft. will house Avco's ballistics range, and 20,000 sq. ft. will house an arc wind tunnel.



COUNTDOWN TIME in firing liquid fuel missiles will be speeded by propellant loading system. Exhibit shows how system permits rapid automatic transfer of missile propellants. System can be modified for use in ground support of any liquid fuel missile.

Propellant Loader Speeds Up Missile Firing

A propellant loading system that materially shortens countdown time in firing liquid fuel missiles has been developed jointly by A. D. Little, Inc. and Minneapolis-Honeywell Regulator Company.

The system, first for any U.S. missile, was developed primarily for the Air Force's 100-ton *Atlas* intercontinental ballistic missile. It permits the rapid automatic transfer of liquid propellants from launching base storage tanks to the missile. Human error is eliminated, increasing accuracy and reliability in fuel transfer. The system, with modifications, can be incorporated into the ground-support equipment of any liquid fuel missile.

Honeywell's Missile Equipment Division in Pottstown, Pa., developed the control system under contract to the Little firm (of Cambridge, Mass.), a prime contractor to the Air Force Ballistic Missile Division.

The *Atlas* uses liquid oxygen (LOX), RP-1, a hydrocarbon—and helium pressurizing gases.

The propellant loading system consists of a relay matrix-type sequencer, indicating and control devices, high pressure shut-off valves and the necessary storage tanks and piping.

The sequencer is the "heart" of the control system, monitoring the action of other system components. It programs the succeeding steps in the loading sequence by verifying its own action.

Automatic programming of the propellants is done with high accuracy, in a safe manner and under stringent requirements, so that there is a minimum of loss of propellants before and after loading a missile.

Two of the precision valves, for example, are designed to exceed rigid military specifications. One, a 10,000-pound high pressure valve with a 6,000-pound differential across it, has a guaranteed leakage rate of no more than one cubic foot per year. Another, a 12-inch LOX valve, has a guaranteed leakage rate of less than 1/200th part of one percent.

Ultra High-Strength Steel Aids Missile Production

An ultra-high-strength steel that is said to make simplified production of missile parts possible, has been announced by U.S. Steel Corp.

According to U.S. Steel President, Clifford F. Hood, the new steel will outmode huge tanks used to oil or salt-quench large fabricated sheet steel missile components.

Designated "Airsteel X-200," the new material was developed after more than two years of research effort, and is the result of "proper balancing of various alloying elements," Hood said. After tempering, it develops tensile strength levels in the 280,000 psi area, without oil or salt quenching; has a tensile strength level six times that of sheet steel used in automobile bodies; and can be welded by conventional methods with an "unusually high" weld seam strength.

The metal is produced in an annealed (soft) condition, and, according to the manufacturer, can then be readily worked or formed to missile configurations. After forming, the section is heated and left to cool at normal air temperatures, in order to develop strength and hardness.

Its advantage, according to the steel company, is that missile steel of this strength level, chemical composition and weld effectiveness usually requires quenching in oil tanks to develop high mechanical properties in thin-walled missile applications. Airsteel, however, won't need such tanks as a part of the manufacturing operation.

Navy Awards Contract for Packaged Liquid Engines

In an action said to be the first military commitment for production of such units, the Navy last week awarded a contract for production of packaged liquid rocket engines. The move was said to be the first step in development of a "family" of liquid propellant rocket engines based on a specialized design concept developed by the manufacturer.

The contract, for an undisclosed amount, went to Reaction Motors Division of Thiokol Chemical Corp., Denville, N.J. Under the cognizance of the Navy's Bureau of Aeronautics, the contract covers production of the rocket engine which Reaction Motors has designated as the *Guardian*.

The engine, LR 44-RM-2, can be supplied in fully-loaded condition, complete with propellants loaded at the factory, Reaction Motors said. Based on simplicity in design and operation, the *Guardian* engine is said to be an integral unit which includes propellant tankage, thrust chamber and all components necessary for its operation. Officials said the engine can be safely stored, and fully loaded with propellants for "extended periods" of time.

Lockheed To Produce Ground Support Equipment

One of the nation's largest aircraft manufacturers has announced it has entered the allied field of producing ground support equipment for missiles and aircraft.

Lockheed Aircraft Corp., Georgia Division, has established a "Special Products" branch to design, develop and produce support equipment. It will also sub-contract work for other companies on tools, parts and assemblies, and sell services.

• Ground-Support for Missiles Calls for Special Design
• Few Single Firms Can Supply It. That's Why . . .

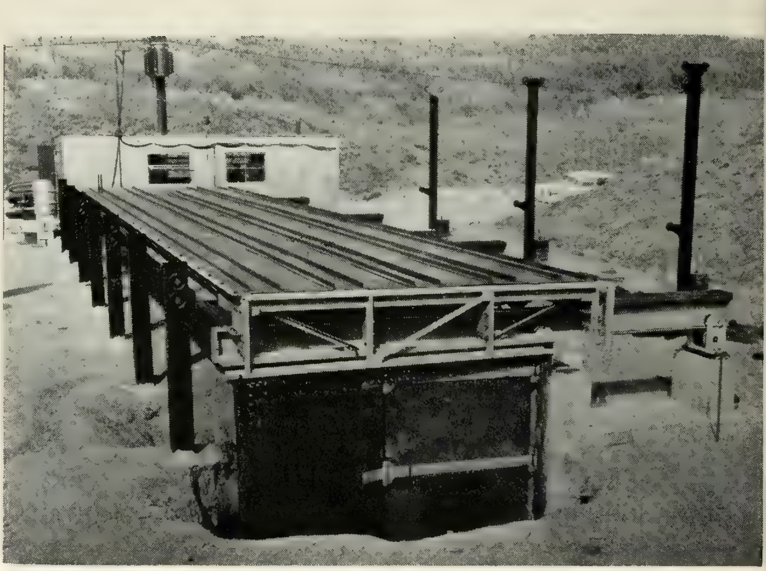
Thompson Products Assembles A Special Team

by Richard Van Osten

LOS ANGELES—With ground equipment reaching the economic proportion of 70% of the cost of a missile system, industry is faced with a new challenge—the creation of simple, economic hardware that performs with reliability and precision.

That's the spur behind the recent creation of the Tapco Group by Thompson Products, Inc. This move by Thompson's management places the company's five divisions—Accessories, Jet, Electronics, Pneumatics and West Coast—under a single sales, engineering and administrative management team to coordinate the design of components and subsystems for missiles.

Among the products undertaken by these divisions, either individually or cooperatively, are: a mobile launcher for a tactical missile; a mobile ground checkout system for a missile autopilot; a hydraulic supply unit; a launch pad cooling system; a checkout building coolant system; and a fuel transfer service vehicle.



SHELTER for *Bomarc* poses problem in mobility and weight-carrying.

• ***Bomarc* shelter**—An example of the projects that missiles have made necessary is the Thompson-built roof panel and door actuation system for the *Bomarc* missile shelter (see photo). This task was assigned under contract with Burns & Roe, Inc., prime contractors for *Bomarc* handling and service equipment. First installation of the system is to be at Suffolk AFB, N.Y., in late summer.

Design requirements for the roof and door actuation took the job out of any run-of-the mill project class.

The 10 x 60-ft. roof panels, weighing nearly 15 tons each, present an effective roof area of 10 x 80 ft. With all possible wind and snow loads taken into consideration (max. snow load assumed at 30 lbs. per sq. ft.) the total roof load could reach 54,000 lbs. The specification further required that the roof must open fully in less than five secs.

Coupling the folding end doors with roof panel actuation leaves the 20 x 60-ft. inter-panel space with open ends. The unsupported concrete side walls are subject to the missile's full initial blast, and as the vehicle rises, the power plant's stream is thrown against the extended roof panels.

The final actuation system is a combination of mechanical, hydraulic and electrical components. There are actually two identical interlocked systems, one for each roof half and set of end doors.

• **How it works**—Principal power is supplied by 3,000 psig hydraulic accumulators, one for each system half. A 4,500 psig auxiliary system is provided by a separate component of the system in the event of primary system failure.

Hydraulic fluid is transmitted through a control valve system to a seven-ft. long, double rod end hydraulic cylinder. Stroke of the power cylinder is 71½ in., and the bore is 4.022 in. Drive racks attached to each cylinder end furnish a rotary motion to double pinions mounted in housings in line with each cylinder end. Rack-to-pinion gear ratio is 1:1.833.

When the lower pinion rotates, power is transferred to the roof rack through a second gear keyed to the pinion shaft. Roof, or driven racks, are located at 90° to the shelter walls. Thus, a linear motion parallel to the wall is transferred to a linear motion parallel to roof movement.

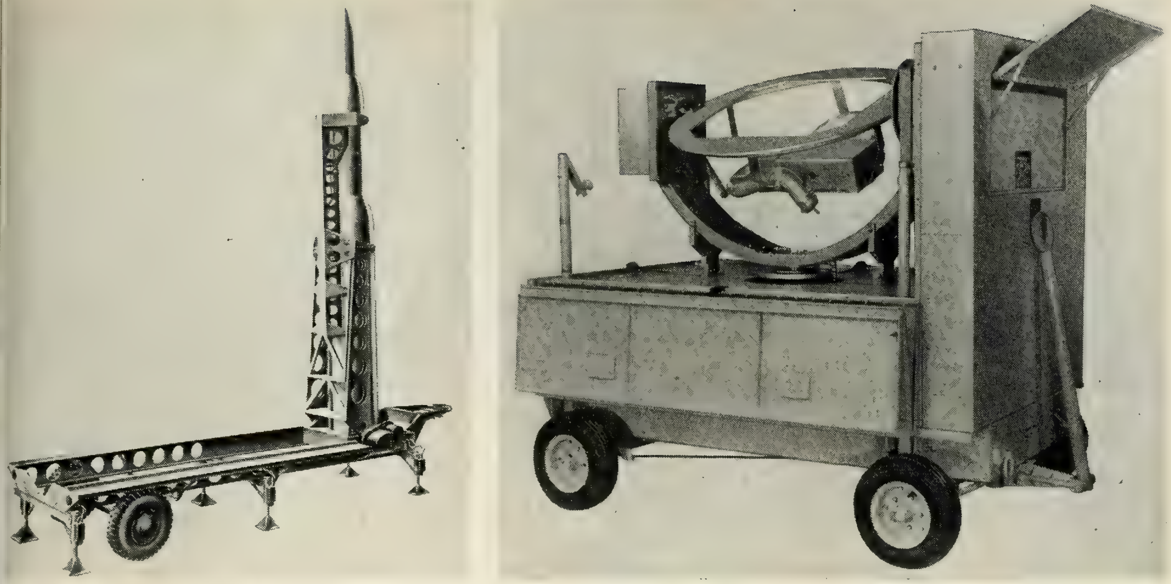
A roof latching mechanism is mounted on the housing and pinion assembly. This consists of a hydraulic cylinder, latch bar and a switch actuating arm. The cylinder piston is actuated by hydraulic pressure for its downward motion and by a spring for upward travel. Switch actuation is integrated into the system's operational sequence.

The 22-in. thick roof panels are held by latch bars which engage slotted brackets mounted on structural roof members.

Adjustment for roof rack-to-gear mesh is provided by a rack mounting that allows for temperature variations without additional stresses. Also, there are two possible locations for each housing and pinion assembly.

Roof deceleration is controlled by a valve which is actuated by a cam bar on the power piston rod. During roof opening, the bar is pulled between the deceleration valve plunger and a back-up roller. When the cam profile depresses the valve plunger, oil flow is diminished and the roof slowed down.

High pressure oil to the power cyl-



MOBILE LAUNCHERS and ground check-out vehicles are only part of the support equipment that must be produced.

inder is controlled by a four-way, pilot-operated, double solenoid, spring offset hydraulic valve on the manifold block. A similar single solenoid valve controls oil flow to the latch cylinders.

A check valve in the manifold block ensures minimum pressure in the hydraulic circuit at all times. Another check valve in the line from the manifold block to the power cylinder allows free oil flow for roof opening, but restricts flow when the roof is closing.

Thompson has built an $80,000 full-scale mockup of one roof panel and end door at its missile subsystem and test center near Roanoke, Va. Approximately 600 test cycles have been run to date with 925 cycles necessary for test completion. Specified service life is 10 years, but cycles completed equal 25 years of operation.

• **Trailer erectors**—The Tapco Group is also developing a trailer-erector mobile launcher for a tactical missile that will transport the missile over rough terrain as well as highways. Incorporating elevation and positioning mechanisms, the missile may be fired directly from the transport without deflection or damage to the vehicle.

Simple in design, the launcher can be positioned, leveled and stabilized and ready to fire in less than 25 minutes. The elevating mechanism returns the missile to transport position if plans are changed. All accessory power is supplied by a prime mover attached to the transport-launcher during the mission.

Several design criteria were established by Tapco to meet basic logistics of high mobility, utility and minimum setup time for the launcher.

The first was reliability for safe and successful mission completion. This led to a high degree of vehicle utilization and reduced over-all system cost. Second criteria was low weight and minimum size to increase mobility and airlift capability. Lower weight also means lower costs.

Maintainability was the third criteria. An attempt was made to reach an optimum balance between feasible levels of personnel efficiency and mechanical complexity to minimize maintenance problems.

• **Organization**—Several divisions of the Tapco Group as well as other Thompson divisions are supporting the development program. The automotive divisions are contributing to the design and production of running gear parts—brakes, axles and suspension systems. (The company late last week also acquired Federal Industries, Inc. of Detroit, a producer of transmissions and power-steering pumps.)

The West Coast division will furnish the hydraulic actuators and control valves, and the Electronics division is involved in assembly and fabrication of the control console prime mover connection. Some component fabrication and all system assembly and test will be done at Thompson's Cleveland, Ohio plants.

Phase I, an eight-month development program, includes design completion, component procurement, preliminary qualification tests and the delivery of several research and development units to the prime contractor.

Phase II will include Thompson's participation in contractor field tests, including actual firings. These and other tests will be required to qualify the unit for production release.

In the design and development of the ground checkout vehicle for a missile autopilot, Tapco's Electronics division delivered two completed units within seven months of starting the project. For such units as the hydraulic supply system, launch pad coolant system, checkout building coolant system and the fuel transfer service vehicle, the Accessories division was ideally suited for the tasks because of its experience in design, development and production of aircraft hydraulic, pneumatic and fuel system components and accessories.

The Thompson group reflects a growing trend throughout the missile industry—a gathering of corporate ability to diversify activities. It might be roughly described as a variation of the much-overworked term "systems management," which is little more than coordination of proven capabilities.

In Tapco's field of activity, ground support equipment, this coordination of effort should take on new importance as more and more weapons systems come into operational use. Present estimates range from 30 to 70% as the figure which will represent the ground support's share of the missile dollar when most of the weapons systems now in various stages of development become tactical devices in the hands of troops.

missile people in the news

Management

Harold E. Gruen recently joined Delta-f Inc., Batavia, Ill., as vice president of Engineering. Delta-f designs, develops and manufactures precision frequency control equipments and systems for the electronics industry. Gruen comes to Delta-f from Armour Research Foundation, where he served as a research engineer.

Dr. Stephen F. Malaker was elected to the board of directors of Trio Machine Works, Inc., Philadelphia. Dr. Malaker is president of Stephen F. Malaker Associates of Newark, N.J., consultants in atomic energy and electronics, and professor of nuclear engineering at the Newark College of Engineering.

Lt. Gen. Roger M. Ramey (USAF Ret.) has become a corporate vice president of Northrop Aircraft, Inc., in charge of the company's district offices. Gen. Ramey will supervise the activities of Northrop offices in Washington, D.C.; Dayton, Ohio; Omaha, Neb.; Ogden, Utah; Huntsville, Ala., and Colorado Springs, Colo.

John J. Black was elected assistant treasurer in recent action by International Business Machines Corp. He was formerly controller for the company's Data Processing Division, which manufactures and markets IBM computers, and accounting machines.

Richard M. Johnson was appointed president of Koehler Aircraft Products Co., subsidiary of New Britain Machine Co. The announcement was made in conjuction with the retirement of **R. T. Firsbie,** chairman of New Britain's executive committee.

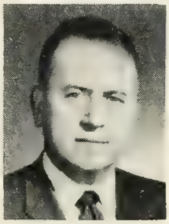
William H. Balentine, manager of the Instrument Division, has been named a vice president of Thomas A. Edison Industries. He will continue as manager of the division, a post he has held since August, 1957.

Everett J. Long was appointed director of the Transducer Division, Consolidated Electrodynamics Corp. Long was formerly assistant director for operations of the Transducer Division. Joining CEC in 1952, he was manager of the Special Products Divisions before becoming production manager of the Transducer Division.

Warren F. Morgan has become vice-president in charge of marketing at Federal Electric Corp., Paramus, N.J. He had been vice-president in charge of customer relations.

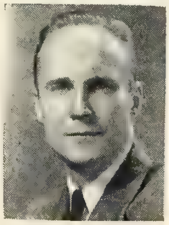
Department Heads

Oscar B. Robey has joined Motordyne as head of the company's new Gyro Division. The new division will manufacture precision gyroscopes for the aircraft/missile industry, in addition to various gyro-type devices such as "pancake" synchros and special torque motors.



Edward R. Nauman has been appointed general manager of the Longhorn Division, Thiokol Chemical Corp. He succeeds **W. R. Ignatius,** who recently died. As general manager, he will direct activities at the Longhorn Ordnance Works, a government facility Thiokol operates for the Army.

A. J. Toering has been named manager of the new Defense Products Department of Callery Chemical Co. The new department will offer technical service on fuels and propellants to the aircraft and missile industry and to the Department of Defense.



Roy J. Sandstrom was appointed to the post of technical director of the Martin-Bell management team for the Dyna-Soar manned space vehicle, Bell Aircraft Corp. As technical director of the Dyna-Soar project, he will be in complete charge of design, planning and construction of the space vehicle.

Jay L. Fisher has been named production manager for the Federal Instruments group of the Industrial Products Division of International Telephone and Telegraph Corp. He will be responsible for planning and directing plant production, purchasing and production control operations for the division's large screen oscilloscopes, bar graph oscilloscopes, swept frequency generators and other electronic precision instruments and instrumentation systems.

A. A. Sroka has been promoted by Ampex Corp. from instrumentation sales manager in its Central Atlantic district to national sales manager for its Instrumentation Division.

Harry A. Carragher was appointed District Representative in the Washington, D.C. office of Land-Air, Inc. He will be responsible for government activities of the company's Washington District.

Engineering

Homer Austin was appointed by Whittaker Controls Division of Telecomputing Corp. as field engineer in charge of its new Fort Worth-Dallas Field Engineering Office. Austin brings to Whittaker experience in the aviation and missile controls field through service with Lockheed, North American Aviation, and Aviation Maintenance Corp.

Jack D. Zeff, formerly a chemical production engineer with the Toni Division of the Gillette Co., has been appointed a research engineer with American Machine & Foundry Co.'s Mechanics Research Division.

advertiser's index

Aerojet-General Corp., Sub.-
General Tire & Rubber Co. 8
Avco Manufacturing Corp. 35
Clifton Precision Products Co., Inc. 36
Diversey Engineering Co. 4
Hydro-Aire, Inc. 2
Solar Aircraft Co. 3

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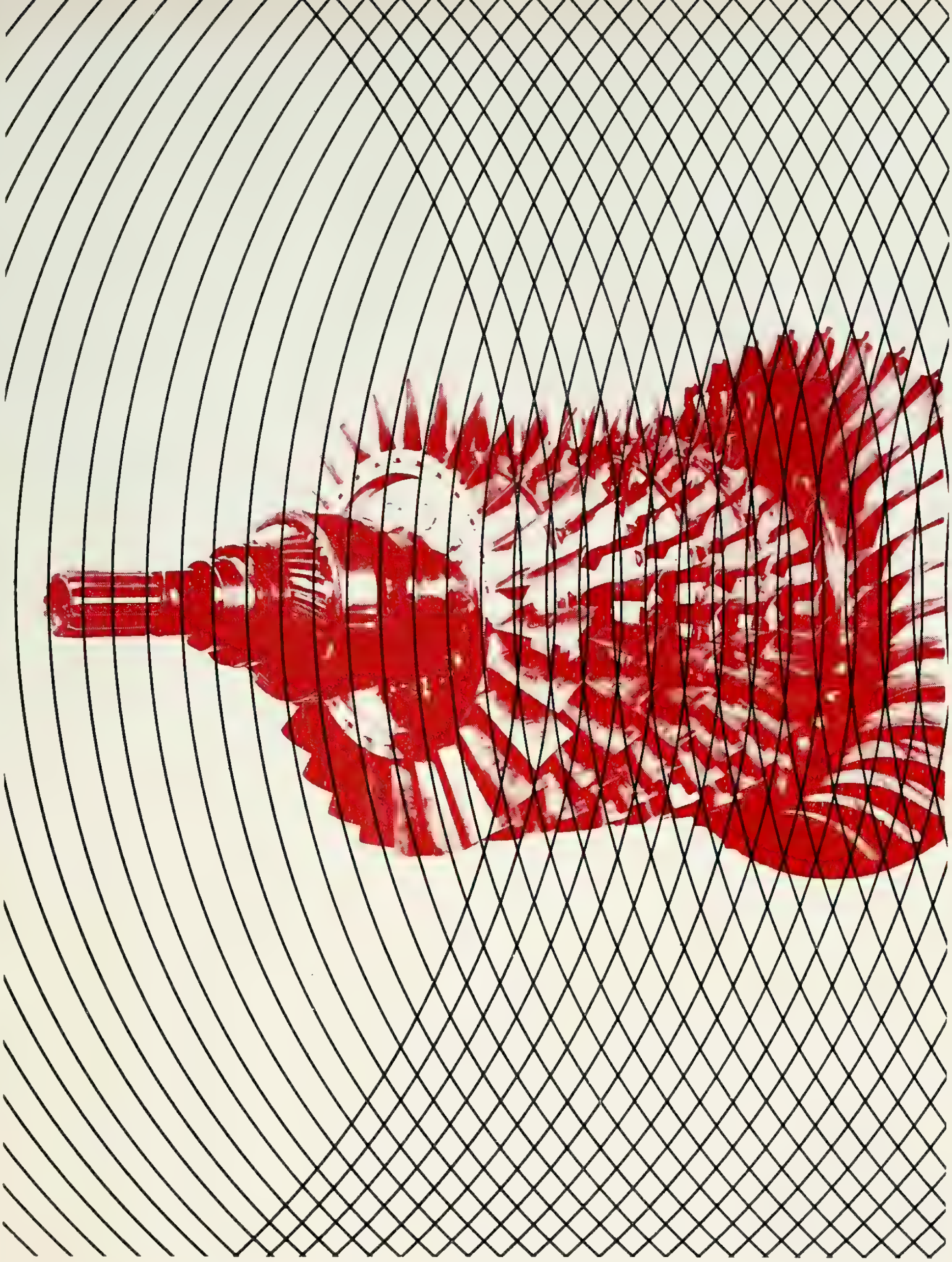

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missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

Engineering and Electronics Edition

AN AMERICAN AVIATION PUBLICATION

4

NEW

Automatic, Transistorized, Mercury-Relay

Digital Voltmeters for Missile Check-out Systems

SERIES 20

MODEL 24
4-DIGIT VOLT-OHMETER
Measures DC Volts, Voltage Ratio, and Ohms

MODEL 25
5-DIGIT VOLT-OHMETER
Measures DC Volts, Voltage Ratio, and Ohms

MODEL V-24
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Measures DC Volts

MODEL V-25
5-DIGIT VOLTMETER
Measures DC Volts

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CONVENIENCE

Easiest to operate, easiest to read. Only NLS provides all of these features in one compact instrument: automatic range changing, automatic decima placement, automatic polarity indication . . . exclusive snap-in readou with no-glare hood . . . plug-in component modules throughout.

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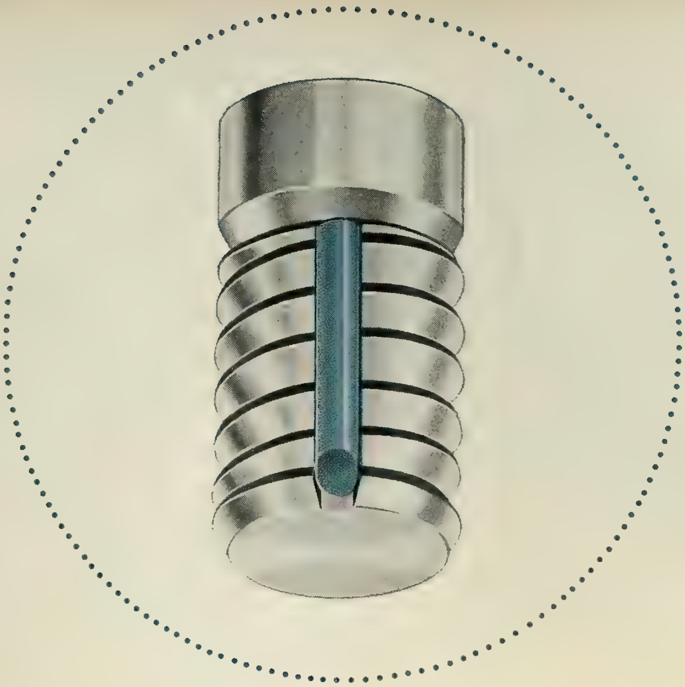
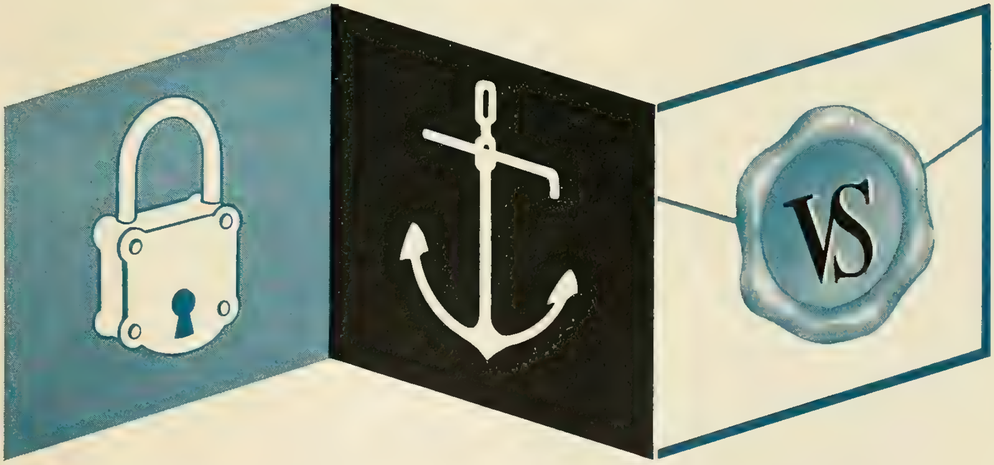


LONG-LOK INSERTS: a positive solution to fastening problems that...

LOCK, ANCHOR & SEAL



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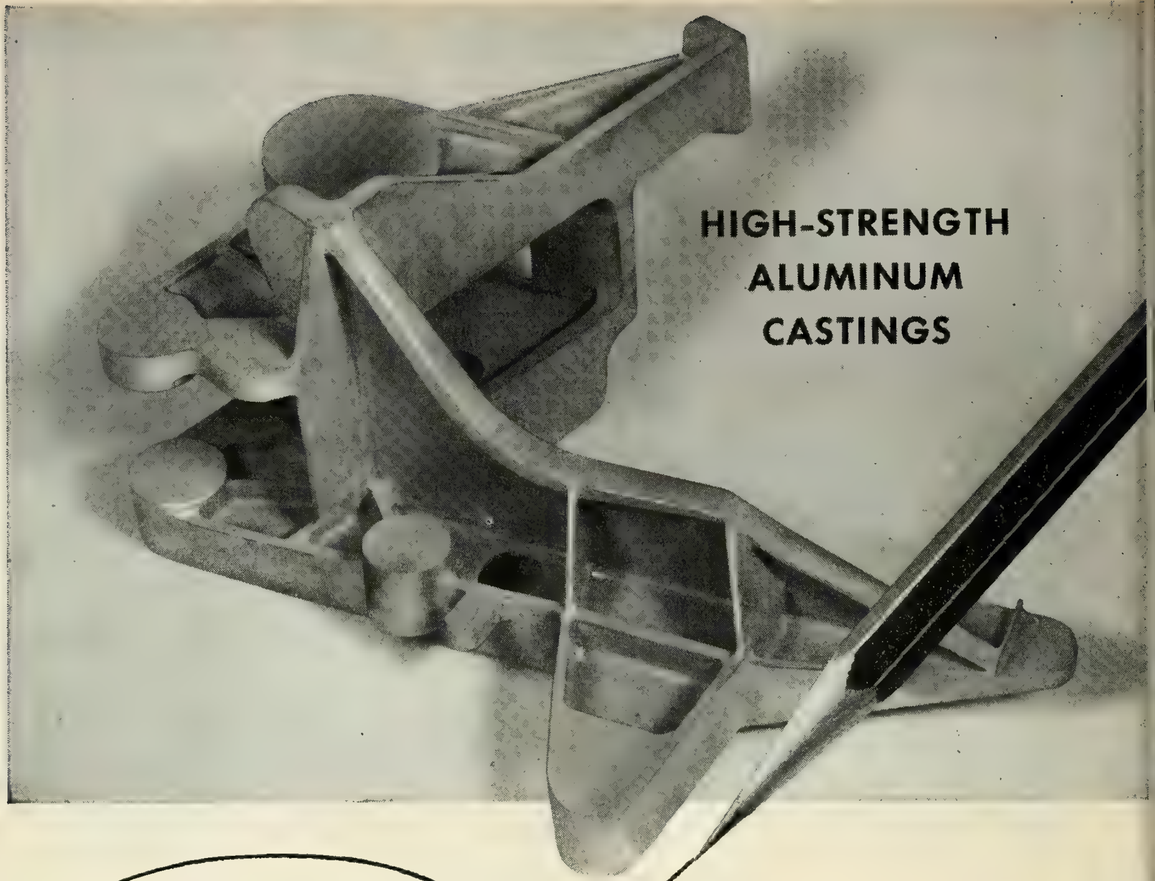

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missiles and rockets

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news

Project *Adam* Converted to Transport Attempt
by Donald E. Perry 14
Navy Simplifies Surface-to-Air Missiles 15
by William O. Miller
Call for International Convention On Space Law 16
SAC Crews Start *Atlas* Training 18
Missile Firing Subs Held Threat to U.S. 17
by Frank G. McGuire

features

an m/r special report

Wires and Cables: Vital To Missiles
by Peer Fossen, Raymond M. Nolan 23
The Human System In Space
by C. Wright Reininger 33
Why A Patent Attorney In Space Age?
by Robert Levine 38
Magnesium: Will It Find Biggest Market In Missiles?
by Carl N. Mortenson 46
Soviets Certain They'll Be First On Moon
by Dr. Victor P. Petrov 50

columns

West Coast Industry 61
Keeping Track 75
Soviet Affairs 88
World Astronautics 98
Space Age 101

departments

Editorial 7
Industry Countdown 9
Washington Countdown 13
When and Where 36
Contract Awards 61
New Missile Products 65
Book Reviews 70
Missile Electronic News 75
Moscow Briefs 91
Letters 102

cover

Dusk firing of the TERRIER missile from the battleship "Mississippi" three years ago set sea birds a-flutter and pointed the way for present day installations on board the "Boston," "Canberra" and other cruisers currently being converted to accommodate the air-to-surface bird. Even though previous tests of launching systems, radars and computers had been carried out from the U.S.S. "Norton Sound," the system on "Ole Miss" was the Navy's first experimental tactical installation. (See page 15 for latest developments.)

MISSILES DEPEND ON AIRCRAFT QUALITY STEEL* from *Acme-Newport*

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World Astronautics

Astronautics is inherently an international endeavor, according to the delegates of the various IAF member societies.

At the IAF Congress in Amsterdam a week ago, a bold four-point program of international cooperation in spaceflight was adopted: it called for the collection and dissemination of information from one focal point concerning the plans and progress of spaceflight research activities of all nations. Further, the proposal called for international competition for selection of a number of research experiments to be conducted in earth satellites, and the establishment of a significant number of scientific research fellowships in astronautical subjects. An international conference for peaceful application of rocket vehicles, similar to an atoms-for-peace conference, also was proposed.

It may well be that the limitless space beyond the thin shield of the earth's atmosphere has no national boundaries. It may also be that a "dynamic situation exists today wherein a vacuum of knowledge pertains in much of the world with respect to detailed knowledge of the aim, problems, and progress in astronautics" as was pointed out by one American IAF delegate.

Undoubtedly, scientists and engineers in all countries would like to study, work and become identified with the evolution of astronautics on an international basis. We understand and respect this view. We are for World Astronautics.

We believe peaceful international achievement in any area of astronautics looms as the most promising of all man's advances. We also believe that much can be accomplished toward this goal through the formation of an international organization and possibly an international astronautics research academy, but we certainly do not believe that the International Astronautical Federation—with its incomplete organizational and inadequate financial structure—is capable of achieving any of these goals for the time being.

There was a time, not long ago, that the IAF needed the support of big-name scientists. Professor Theodore von Karman, at an informal luncheon in Amsterdam last week, put it this way: "We wanted to make astronautics a respectable science—so we invited respectable scientists to join us." Indeed, the IAF now has many outstanding members and its congresses are attended by more and more important researchers and engineers. Why is it then, that the organization is so weak in action?

For several years a handful of energetic enthusiasts—we think Americans Andrew G. Haley and Frederick C. Durant III are among the outstanding ones—have tried desperately to obtain international recognition of IAF.

Haley has made fine progress toward a cooperative effort with important international bodies, including the United Nations, The International Council of Scientific Unions, The International Telecommunication Union and others. However, Haley is only one man, and the IAF will never get off the ground until its president has the support of a full-fledged secretariat and an adequate staff that is capable of rendering the kind of service that is always required to operate an international organization successfully.

It seems obvious to us that the IAF must concentrate on building an internal structure that will eventually lead to outstanding progress in the area of world astronautics. Until then, IAF will only be capable of offering proposals and no action. Indeed, the science of astronautics is about to run away from IAF.

As far as international cooperation in astronautics is concerned, we understand that "The lack of the all-important rocket launching vehicles needed to carry instruments into space . . . is causing a natural frustration." A delegate said: "This frustration, because of human nature, can lead to envy and bitterness." This may well be so, but the United States for one, certainly is not among those nations which are prepared to give away their rocket hardware. We are faced with a life and death race to overtake the Communists in this field.

We appreciate the views of IAF and its proposed drive to "open up" space rocketry to everyone. But as long as we are fighting a cold-war struggle for survival, and as long as we hardly are off the ground ourselves, we cannot see how the U.S. could participate in an international rocket hardware exchange. This country should naturally support a world astronautics science program, but we must take care of ourselves first.

Erik Bergaust

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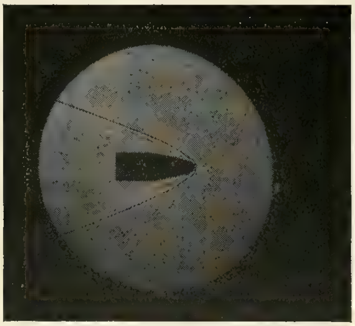

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industry countdown

labor trends

Sylvania Electric Products move to boost pay of non-union hourly workers—while the company continues negotiations with five unions—is being watched. What Sylvania did give to its non-union personnel is the same package it has offered the unions: a two year schedule of pay increases of from 5 to 11 cents an hour this September, a similar boost next August; continuation of cost of living wage and salary formula for hourly and salaried employees through August, 1960; a third week of vacations for employees with 10 years' service, starting in 1959; improvements in hospital insurance, company-paid group medical insurance programs. Curently, about half of the company's hourly employees are union members, and negotiations are being carried on with Machinists, Electrical Workers, Steel Workers, and two other union groups in their behalf. Sylvania added bait for union negotiators: If the company's offer is accepted within a specified period after Sept. 1, increases will be retroactive to that date.

how's business?

Key to the general optimism of electronics manufacturers (and to their generally good earning reports) can be found in expanding government uses of electronics, both for defense (largely missiles) and other purposes. For instance, defense agency outlays for electronics are expected to jump 120% over the next five years; other government expenditures for such items (including airways modernization and computer programs) may rise to a level of $700 million yearly by 1963. Industrial uses for electronics are also rising fast. You can get an idea of what this has meant to industry out of reports such as that just turned out by **Northrop Aircraft, Inc.,** which showed sales of electronic and related equipment at $63 million for the fiscal year ended July 31. That's about 25% of the company's total sales, according to W. C. Collins, Northrop president. More evidence: **D. S. Kennedy & Co.,** which designs and manufactures microwave antennas and equipment at Cohasset, Mass., figures its 1958 fiscal year earnings will double the $6.8 million 1957 figure.

industry view

A sparsely-attended session (on "Project Management-Airframe and Electronic Viewpoint") at the recent WESCON show produced some strong industry opinions on handling of missile work. Said George Stoner, Boeing weapons systems project manager (Dyna-Soar): The difficulty of maintaining the "incredible" pool of skills required makes the contractor wonder (1) how to get paid for his investment (2) whether the prime's position wouldn't be improved considerably if there was an incentive in the contract. Said Richard L. Shelter, General Electric Co.: The decision on who should do systems management should be made on the basis of which technology controls the system. Oscar Simpson, Philco Corp., had some words about electronic firms as system managers: Some can handle the job, but many are too specialized for it. Final word was spoken by Col. Edward N. Hall, USAF's Ballistic Missile Division, who insisted: Systems management is a choice of who can do the best job at lowest cost.

company notes

Acme Precision Products Inc., Dayton, Ohio, "expects to acquire" **Cal-Tronics, Inc.,** Los Angeles electronics firm . . . **Cubic Corp.** has licensed the Italian Firm OTE to produce Cubic's SECOR missile tracking equipment on a royalty basis. The Italian-made equipment will be used on a missile test range planned by Italy on the island of Sardinia . . . **Aerojet-General** has set up a new systems analysis department within its Avionics Division . . . **American Missile Products Co.,** Lawndale, Calif., will supply electronic components to **Hughes Aircraft Co.** from a newly-opened plant at Fullerton . . . **Mitre Corp.,** a nonprofit group sponsored by Massachusetts Institute of Technology, has been setup at Cambridge, Mass., to provide Air Force with a defense management system. Head will be H. Rowan Gaither of the Ford Foundation.

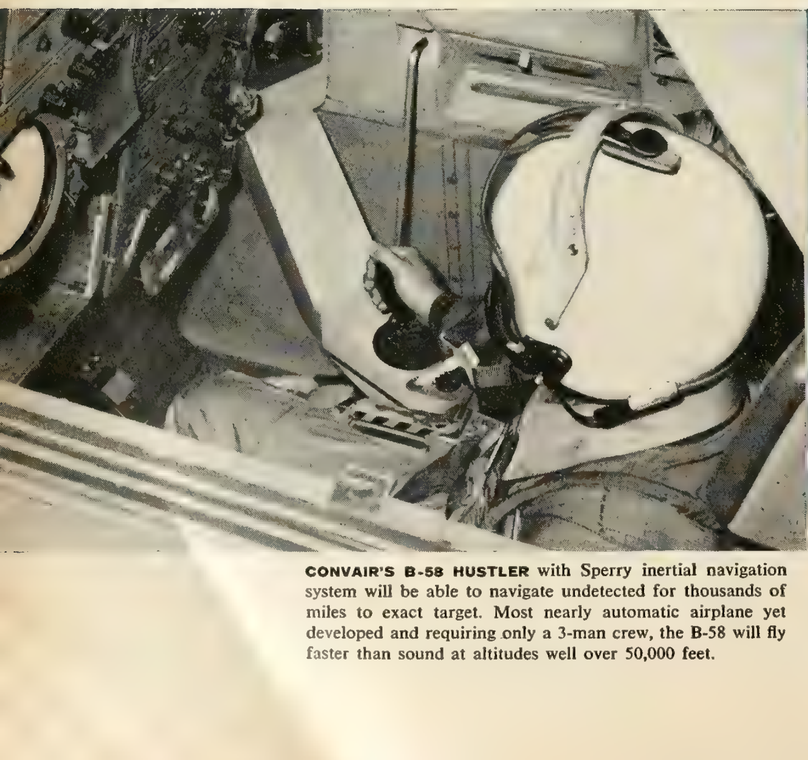
ADVANCED INERTIAL GUIDANCE

Complete systems or components for aircraft, missiles and spacecraft

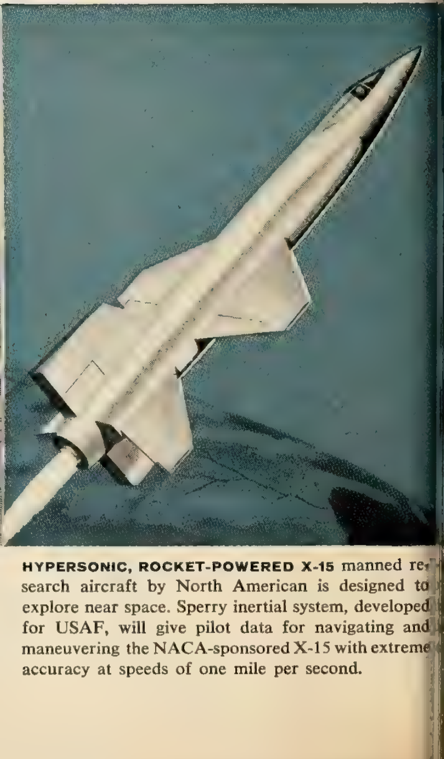
To design and produce extremely accurate inertial guidance systems requires a complex combination of engineering and manufacturing skills. Each component must be developed to meet the accuracy needed for the system's mission.

The long background in gyroscopics, electronics and computation has made it possible for Sperry to design and produce advanced inertial systems for some of our country's most modern weapons of defense. Other Sperry inertial systems will, one day, allow man to explore space.

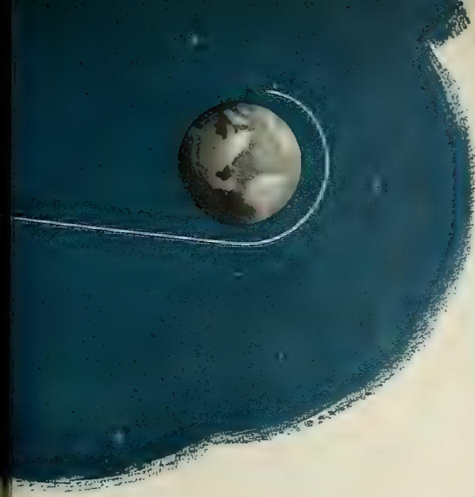
On these pages are highlighted some of Sperry's recent achievements in inertial guidance. If you have a systems problem or are interested in individual components, write our Air Armament Division for further information.



CONVAIR'S B-58 HUSTLER with Sperry inertial navigation system will be able to navigate undetected for thousands of miles to exact target. Most nearly automatic airplane yet developed and requiring only a 3-man crew, the B-58 will fly faster than sound at altitudes well over 50,000 feet.



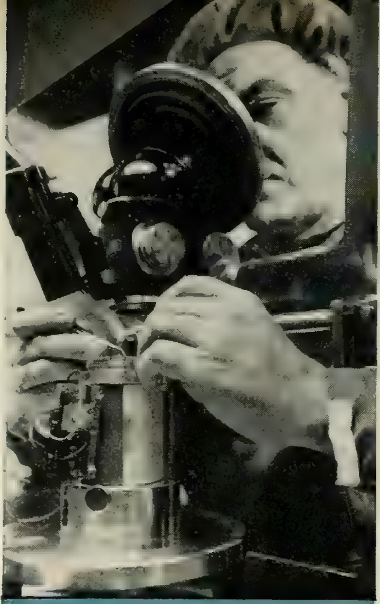
HYPERSONIC, ROCKET-POWERED X-15 manned research aircraft by North American is designed to explore near space. Sperry inertial system, developed for USAF, will give pilot data for navigating and maneuvering the NACA-sponsored X-15 with extreme accuracy at speeds of one mile per second.



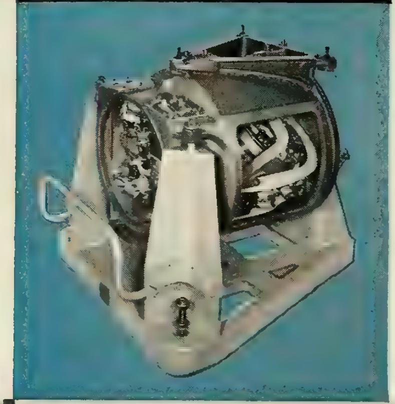
IR ARMAMENT DIVISION

PERRY **GYROSCOPE COMPANY**
Great Neck, New York

VISION OF SPERRY RAND CORPORATION

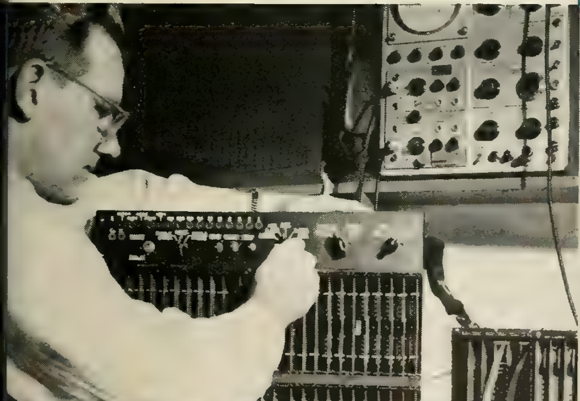


UNDER MICROSCOPE. Sperry employee assembles floated gyros under specially-designed hood and in sealed pressurized room. Since even dust speck might cause serious error in a long-range mission, every precaution is taken in the production of these critical units.

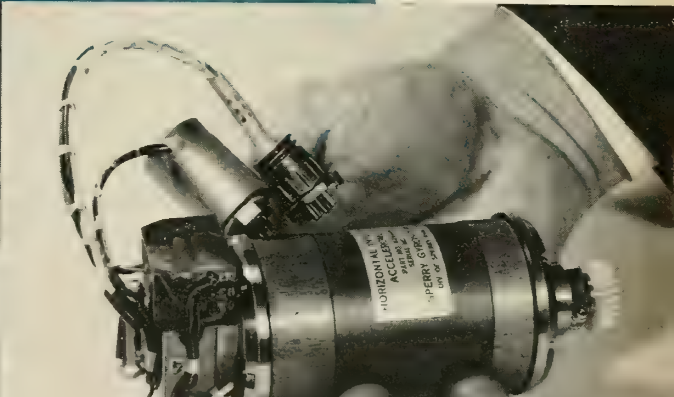


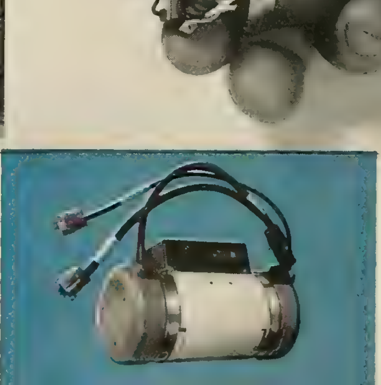
COMPACT Sperry stable platform mounts three advanced floated gyros. Nerve center of the inertial system, platform serves as fixed space reference in flight for maintenance of prescribed course.

NEW linear integrating accelerometers weigh only 1½ lb., measure exact velocity of aircraft or missile in any direction. New sensing mechanism moves in straight line, eliminating errors inherent in previous types. ↓



GINEER TESTS new airborne digital computer designed Sperry. Computer accepts data from stable platform's ros and accelerometers, gives instructions for automatic rrections in flight path. Closely related operator displays rmit inflight monitoring and control.





← **ULTRA-SENSITIVE** floated gyroscope minimizes random drift, assuring high performance for inertial system over long periods. These production gyros withstand shock and vibration many times the force of gravity.

Circle No. 8 on Subscriber Service Card.

THESE FLAME-PLATED TURBINE SHAFTS

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Turbine shafts in ballistic missiles must turn smoothly at terrific speeds . . . stand up under intense heat. That's why critical points of wear on these shafts for Atlas, Thor, and Jupiter missiles are Flame-Plated by LINDE's unique process. Engine systems for all three missiles are built by Rocketdyne, a division of North American Aviation, Inc.

Flame-Plating is LINDE's special process by which a hard, thin coating of tungsten carbide, aluminum oxide, or other materials is applied to a metal surface. Flame-Plated coatings have outstanding resistance to wear, abrasion, and fretting corrosion, even at extreme temperatures. They consistently outlast hard chrome plating, tool steels, and in some cases even solid tungsten carbide. Flame-Plated coatings can be used as coated (125 micro-inches rms), or ground and lapped to better than one micro-inch rms finish.

If you have a wear problem that could be solved by a harder, longer-wearing surface—call your nearest LINDE office and find out what Flame-Plating can do for you. Or write Flame-Plating Department, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, New York.

Principal wear surfaces of missile turbine shafts Flame-Plated by LINDE with tungsten carbide are indicated by arrows.

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washington countdown

The wide-open drive to spend money for missile and space programs shows signs of slowing down. Reason: there is a definite point in development of any weapon where additional money will not buy additional performance. The conduct of R&D programs is now dictated by engineering people who, in the words of one defense contractor, "always hope to achieve the ultimate in design by long and arduous series of changes which cause slippages in program time and hardware delivery."

There is some alarm in Administration circles that the successful launching of more sophisticated satellites (such as weather eyes and reconnaissance vehicles) will bring the issue of territorial rights in space to a head. U.S. policy in these matters is expected to be clarified soon. We won't make any space claims, but won't recognize others either.

Policy-makers might listen to Andrew J. Haley, president of the International Astronautical Federation, who told a space-law conference at the IAF Amsterdam meeting that he hopes the U.S. and Russia—the nations most likely to be the first to land men on the moon—will let the United Nations decide whether earth nations should be allowed to claim moon territory.

There is no restriction on the firing date of the first Army lunar probe. However, the failure of *Explorer* V may keep Army efforts channeled into the determination of the limits and intensities of the radiation band. And an ARPA official said that Air Force firing dates would have no effect on Army attempts.

ARPA will use both the Air Force and Army in the development of higher-thrust chemical engines on the order of one million pounds or more. Army Ordnance Missile Command reportedly has been authorized by ARPA to cluster (probably six) of the Rocketdyne 165,000 pound thrust *Jupiter* engines. Thinking is that this arrangement will give "early availability" of a high thrust engine "sufficient for military requirements," particularly in heavier satellites. Air Force has already awarded Rocketdyne a development contract for a single chamber one million pound thrust engine.

Attempts by the Naval Ordnance Test Station to put a satellite in orbit by launching it from an F8U airplane might not prove to be such a major scientific experiment after all. Latest rumors say that the "satellite" will really be on the order of the metal pellets launched in the Farside series last fall, rather than an orbiting, information-transmitting vehicle.

The concept, though, is not to be discounted. Raising a missile or space vehicle to something over 80,000 feet before launch cuts down first stage thrust requirements considerably. General Electric has been proposing (for over six months) to lift IRBM's to about that altitude with clusters of J79 turbojets. The engines and launcher would be recoverable and would inject considerable economy into the liquid-missile field.

← Circle No. 14 on Subscriber Service Card.

- **DOD Kills Manned Probe, Because . . .**
- **Possible X-15 Duplication**
- **USSR Program May Parallel**

FORWARD SECTION of *Redstone* missile, shown here, would have been used in Army's Project *Adam* proposal to rocket a man 150 miles into space. "Man-in-space" portion has been cancelled because of conflict with X-15 program.

Army To Research *Adam's* Transport Potential

by Donald E. Perry

PROJECT *Adam*—The Army's proposal to put a man into space in less than a year—has been turned down by the Defense Department, but a go-ahead has been authorized to research its potentialities as a transport carrier.

Advanced Research Projects Agency confirmed to m/r that Project *Adam* will not be in ARPA's program for the specific use—man in space—for which it was submitted. However, ARPA considers the plan's transport potentialities worthwhile and will permit the Army to research these areas.

DOD feeling is that Air Force's X-15 rocket plane would be available about the same time as Army's modified *Redstone* rocket. And while Army could get a man higher—150 miles compared to less than 100 miles for the X-15—the experiments possibly would duplicate each other.

The belief that the X-15 will be available at the same time as the modified *Redstone*, is in conflict with testimony given to Congress April 15 by Dr. Wernher von Braun, director, Development Operations Division, Army Ballistic Missile Agency.

At that time, Dr. von Braun said "the X-15 cannot possibly be ready to reach 100 miles altitude at the time when we could hit 150. It will be substantially later (later 1959 or 1960) than our schedule (May or June, 1959 if approval had been given then)."

ARPA told m/r that "many components of Project *Adam* are worthwhile," and it does not intend to bypass the technical competence of ABMA to research these areas. But whether ARPA research funds will be available for Project *Adam's* transport features has not been determined.

Army contends there is a very definite need to use large ballistic missiles of several hundred miles range for the transportation of troops and supplies to fighting areas surrounded by the enemy. The service has pointed out that the use of ballistic missiles as accurate delivery system—fully and directly responsive to the will of the ground commander—will provide the firepower and selective force immediately at critical points where concentration is needed.

• **How to do it**—Use of pressurized capsules in the nose sections of ballistic missiles, Army believes, could possibly be more economical than transportation through the atmosphere by slow-moving troop and cargo-carrying aircraft vulnerable to modern fighter planes.

Large ballistic missiles—particularly the *Atlas* and *Titan*—can accommodate a considerable number of individuals in pressurized capsules along the lines of those now used as ejection devices in high-speed aircraft.

Army is researching ways to reverse the attitude of a missile during its passage through the vacuum portion of the trajectory so that individuals might remain "feet first" throughout. These capsules could be lowered to earth by the combination of parachutes to check velocity and reverse thrust rockets for final stabilization.

In Project *Adam*, the modified *Redstone* (*Jupiter-C*, configuration, minus the upper staging arrangement and Hydyne fuel) would have had a 4,500 to 5,000 feet per second velocity at power cutoff when the nose section would have separated (m/r June, 1958, p. 40).

The capsule would have come to a near standstill at the apex of its ballistic trajectory, gaining a speed of about 5,000 feet per second when it re-entered the atmosphere. Two or three automatic drag parachutes would slow the capsule down and a parachute would have been deployed at an altitude of 7,000 feet.

The flight, lasting about 12 minutes and giving over six minutes of weightlessness, would have given an overall distance of 150 miles from launch point. Army said it could have landed within a half-mile from a waiting ship, giving early recoverability of the capsule and its passenger.

Adam was blasted in some quarters as a "publicity stunt," and the project, which first enjoyed Air Force participation, later was withdrawn. It would have investigated four areas of experimentation: safety of launching rocket, weightlessness, aerodynamic heating, re-entry and recovery techniques. Four flights—costing an estimated $10-12 million—had been planned. The first two would have utilized instrumented monkeys, the last two manned.

• **Russia ready**—Russia's counterpart to Army's Project *Adam* appears to be in full progress with Radio Moscow announcing last week that two dogs had been returned to earth safely after having been rocket launched to an altitude of about 281 miles.

Radio Moscow said a one-stage rocket with a total payload weight of 3,725 pounds took the dogs past a previous record of 132 miles, and special stabilizers prevented the rocket from rotating during flight. U.S. observers believe the experiment was a prelude to efforts to launch a man into space.

A photograph of a dog emerging from a rocket was made available to the U.S. press. It was the same as one published previously in m/r. (April, 1958, p. 61).★

AMC Overhaul To Upgrade Weapon System Offices

Under a major reorganization of the Air Materiel Command announced last week, the Ballistic Missile Office, now headed by Brig. Gen. Ben. I. Funk, will report directly to Air Materiel Chief Gen. E. W. Rawlings.

Aim of the AMC overhaul is to make the current decentralization of authority to Air Materiel areas function, and to upgrade the authority of Weapon System Project Offices.

The Directorate of Procurement and Production, will have its staff elements separated from the operational elements.

The new Aeronautics Systems Office will have responsibility for strategic systems, air defense systems, tactical and support systems, equipment and resources. Strategic systems include strategic and guided air missiles, B-52, B-58, B-70 and advanced nuclear bomber weapon system project offices.

Operational elements, such as the weapons system project offices will stay in their present location. They will, in effect, become an order-placing unit handling major procurement items not shifted to the AMA's.

The reorganization shifts will be made over the next six months. Meanwhile, other steps in general reorganization of DOD became effective last week, with a change in the structure of the Joint Chiefs of Staff. Under the new setup, JCS will work through a director and deputy director of a joint staff; this staff, in turn, to be divided into nine major parts. The JCS secretariat will not be affected.

Navy to Simplify Missile Systems

by William O. Miller

The Navy has taken a big step forward in simplification of its surface-to-air missiles systems with an 85% interchangeability of parts for an advanced version of *Terrier* and the forthcoming *Tartar*. Though the *Tartar* is much smaller, the capability involves certain parts of the air frame, servo systems and guidance systems, and is the result of a deliberate effort to make the two missiles as much alike as possible for logistics reasons.

Additional advantages are seen by Naval planners in requirement of fewer production lines, a simplified and dual-purpose training program for personnel, and a general streamlining of the missiles which rapidly are replacing the Navy's five-in. guns.

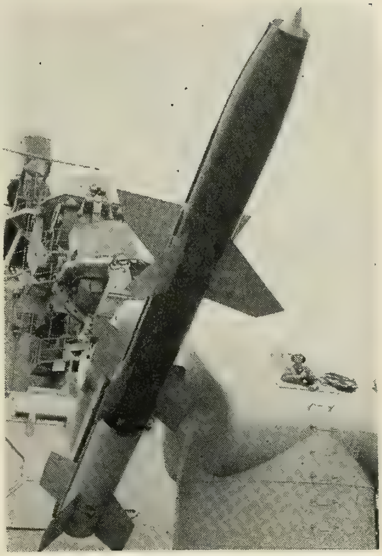
Budgetary limitations and rising cost are a factor, Navy spokesmen admit, but the foregoing points are basic in the philosophy for advanced weapons planning. Simplification and interchangeability, and a reduction in the overall number of missiles, is a strong consideration in any long range planning, they say. By long range planning, the Navy means a project of at least 10 years.

"We'd like to have one missile which we could use for all purposes," one Navy spokesman said, "However, we know this is not practicable. But we do foresee getting along eventually with two—a long and a short range dual purpose missile."

Presently, the Navy has the longer range *Talos*, the *Terrier* and the forthcoming *Tartar*. Navy spokesmen said that the reduction in number is a long range goal, and should not be construed as meaning the elimination of any specific missile from the program. Testimony before congressional committees has indicated that *Tartar* will have the capability of the earlier *Terrier* and it is hoped that eventually *Terrier* will be equal to *Talos*.

Best guess is that there will be a marriage of advanced versions of *Talos* and *Terrier*. The long range capability of *Talos* is good, but its 20-ft. length requires at least a cruiser for a launching platform. Miniaturization of all missiles including both *Talos* and *Talos* (nuclear warhead version) has high priority.

• **Storage life**—Another step forward in the art of making and keeping missiles is an improvement in the "shelf life" the Navy has been getting from some of its missiles. *Terriers* which had been stored aboard an ammunition ship in the Mediterranean for more than eight months recently were tested, with an extremely high percentage of satisfactory checkout. In fact, the Navy recently has cut the number of tests required for *Terriers* in storage to one-third. The same high reliability is anticipated for *Talos* and *Tartar*, a Navy official said.



MAIN BATTERY of the Galveston type cruisers will be the long range ***Talos.***

While not yet in the production stage, the Navy is reported highly pleased with the recent tests of prototype *Tartars*. *Tartar* is expected to be ready for the first of the new construction destroyers scheduled for completion in 1960 (m/r July 14).

Simplification, reduction in numbers, interchangeability of parts, extensions of range, increase of payload and development of dual purpose capability are all fruits of the Navy system. As rear Admiral P. D. Stroop, Chief of the Bureau of Ordnance recently told a congressional subcommittee:

"The risk, technologically and economically, of producing an obsolete weapon on quantity is materially reduced by projecting research and development work well into the production of missiles.

"In procurement of missiles, the Bureau of Ordnance has followed a modified approach to what is known as the weapon system concept; the extent of modification being determined by the complexity and utlimate use of the particular weapon in question."

Despite a reduction in the number of different missiles, the scope and speed of Navy missile advances points the way to the eventual exclusion of all other weapons, many observers predict.

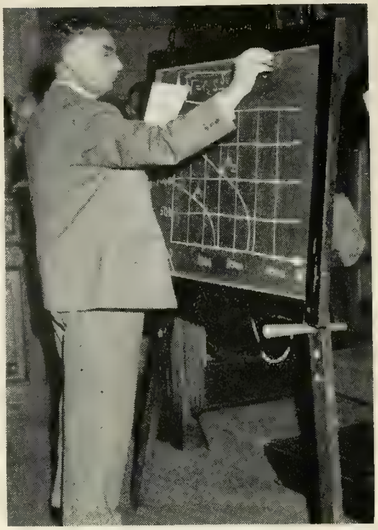
UN To Rule On Space Law?

THE HAGUE, NETHERLANDS—A new international convention should be established to settle legal problems involved in the development of international astronautics. This was resolved by a colloquium on space law of the International Astronautical Federation.

(Meanwhile, the National Academy of Sciences at Washington announced the appointment of a four-man committee of scientists, headed by Dr. W. Albert Noyes, Jr. of the University of Rochester, to propose a U.S. program for international control of space exploration.)

Attended by legal experts from 20 countries, the colloquium called for the setting up of a permanent legal committee within the framework of the IAF to study space law problems. It also resolved that the United Nations should be informed of the plans approved by the colloquium. Some delegates felt that the United Nations itself should tackle the question of establishing a special agency to work out legislation for "the fourth dimension of our age."

There was general agreement among delegates that the International Civil Aviation Organization is not the agency that should be entrusted with doing the spade work on this problem. U.S. Congressman K. B. Keating, New York, put it this way: "There is a very real likelihood that ICAO, both by its charter and because of predisposed and specialized ways of thinking, is not the proper agency for the job.



DR. L. E. SEDOV, chief Russian delegate, explains rocket principles.

- **Flight plans?**—Keating suggested a number of topics for discussion on a code for outer space: the filing of "flight plans" for satellites and missiles; continuing agreements for exchange of technical information on the performance of spacecraft and the accumulation of data; workable schedules for spacecraft broadcasting (use of frequencies, single codes, cooperative triggering of transmissions to permit more accurate reception of information); return-to-earth covenants (surrender of craft downed on foreign soil, and liability for possible trespass and damage); navigational cooperation to facilitate fixes, telemetering and rescue; possible agreements on safe passage for scientific craft.

Army

ARMY TECHNICIANS ready Thiokol's new rocket motor for first static firing at Redstone Arsenal. The solid propellant rocket motor achieves a thrust of possibly 450,000 lbs. for a short duration, and probably will be used in the *Nike-Zeus* air defense missile.

Several experts suggested that the IAF should go slowly in its study of the problems of space law.

John Cobb Cooper, for example, believed that before any recommendations are made by IAF it should be decided whether to pursue the objective of an air-space upper boundary, or whether to consider the proposals for new international agreements dealing with flight control irrespective of the sovereign status of different space areas.

- **Terminology?**—Other experts believe that the first task in tackling the problem of space law is to define the terminology involved. They would like to see IAS compile a glossary of terms used in matters relating to space flight. In order that future developments in space flights will not be impaired, some spokesmen caution against making an international convention too restrictive in its wording.

The problems caused when a space vehicle returns to earth were discussed by Dr. I. H. Ph. de Rode-Verschoor of the Netherlands. She stated that nations are responsible for their satellites when they return to earth, and third parties must be protected as much as possible.

George J. Feldman, director and chief counsel for The House of Representatives' Committee on Astronautics and Space Exploration, called for adherence to the twin principles of freedom of outer space for non-exclusive peaceful purposes and the prohibition of military uses, particularly for atomic and nuclear warheads.

- **Officers**—At final sessions, IAF delegates re-elected Andrew G. Haley of Washington as president.

Named as vice-presidents were: T. M. Tabanera of Argentina; E. Saenger of Germany; L. R. Shepherd of the United Kingdom; L. E. Sedov, Soviet Union; K. Zarankiewicz, Poland. J. Stemmer was re-elected secretary. The delegates selected London, in mid-September of 1959, as the site and date for next year's meeting.

Navy to Build $10 Million *Polaris* Facility

A $10 million *Polaris* missile assembly will be built at the Naval Ammunition depot, Charleston, S.C.

Construction work will be begun late this fall and will be completed in about 16 months. The new facility will be built 18 miles North of Charleston on the Cooper River.

- *Polaris* Subs Have Bomber's Striking Power
- Separate Funding For These Subs Urged
- Bureau System of Management Criticized

Red Missile Subs Held Threat To U.S.

Frank G. McGuire

A REPORT whose importance is far greater than its size has been released by the Joint Committee on Atomic Energy. The 14-page document on underseas warfare was compiled by the advisory panel of the Military Applications subcommittee and makes a number of serious revelations about our missile-submarine capabilities as compared with those of the USSR.

Two recommended actions which would give the U.S. undersea fleet its biggest boost would be separate funding for the *Polaris* system and a change in our submarine thinking. At the present time, funds for *Polaris* submarines come from the Navy's regular shipbuilding budget. This appropriation covers the building of carriers, cruisers, frigates, destroyers, tenders, and all of our other naval vessels.

"A *Polaris*-launching submarine is thus treated fiscally like any other naval vessel," the report points out. "In terms of its military mission, however, it is radically different from the other ships of our fleet."

"Actually, the *Polaris* system is a part of our national military deterrent against all-out war. It is an instrument of strategic reprisal. It is more analogus to a SAC bomber or a land-based IRBM or ICBM than to other ships of our Navy."

"We recommend that, for funding purposes, the *Polaris* system be entirely removed from the Navy's shipbuilding budget . . . that construction budget requests for the *Polaris* system be determined by the Secretary of Defense and the National Security Council, as part of our overall strategic deterrent budget."

• **Defense Preparations**—The advisory panel lists 17 findings, including:

1. The time is rapidly nearing when the Soviet Union can possess a large fleet of IRBM-launching nuclear-propelled submarines.

2. The Soviets could mount a devastating nuclear-warhead attack from the sea against the U.S. early in the 1960s.

3. Our existing defensive system could not stop such a missile attack.

4. No weapons system now in existence, even on an experimental basis, offers an adequate defense against non-snorkeling submarines which run quiet and deep.

5. It is very doubtful whether the present scale and scope of research and development in undersea warfare will give us an effective defense against nuclear submarines in time to meet the threat.

6. Although defense against *Polaris*-type submarines may soon equal the problem of air defense in urgency, the funding of R&D in support of operational requirements for ASW (anti-submarine warfare) has been grossly inadequate, when compared with the support given such programs as air defense and missile development.

7. Assuming no modification of our present and planned submarine-construction program, it is believed that the Soviets will have it within their capability to build a larger nuclear submarine fleet than our own by the mid-1960s.

8. The *Polaris*-system possesses unique advantages as a deterrent force, and it is a matter of national importance that a force of *Polaris* submarines be brought into being at the earliest possible date.

9. The bureau system of the Navy has serious shortcomings in the present era of highly integrated and complex weapons systems.

• **Recommendations**—The report, noting that "The sea could be our enemy as never before," holds a warning tone throughout and makes twelve recommendations for correcting the problems cited. It suggests at doubling the Navy's R&D budget for ASW work in 1959, with substantial increases later.

Great emphasis is also placed on increased basic research, on oceanography, and utilization of private research facilities such as universities. The scale and rate of our attack submarine construction program should be significantly increased, according to the report, and the Navy should immediately proceed with the building of an initial task unit of nine *Polaris* submarines.

The advisory panel recommends that development of underwater atomic weapons be increased and that information be gathered on the nature and effects of underwater atomic explosions. A "limited number" of vertical management organizations, under officers reporting directly to the Chief of Naval Operations, should be established for such projects as ocean surveillance systems and attack submarine systems.

During World War II, the report points out, we confronted a maximum of 440 German U-boats, not equipped with snorkels, and with limited underwater endurance. The speed of these craft did not exceed 12 knots underwater. Facing this menace, we had a total of 950 ocean going escorts and 2,200 ASW aircraft.

The U.S. now has 300 escorts and approximately 700 ASW aircraft, operating against a Soviet undersea force numbering about 475 vessels with much greater range, speed and destructive capability than any of the German fleet.

McElroy "Won't Be Pushed" Into Spending

• **Chicago**—The spending ceiling on long range ballistic missiles has been reached for the present, Secretary of Defense McElroy told the national convention of the American Legion.

"In the business of the defense of America, we are willing to take greater gambles on weapons than the boards of directors of business enterprises would vote to risk on untried products.

There is a point, however, beyond which gambling huge sums on untried weapons would be foolhardy—would, in fact, endanger the economic, and even the military, security of the country," the defense chief said, "In the development of our long-range ballistic missile programs, your defense board of directors believes we are at the point where spending of more tax dollars would, at this time, be an unwarranted risk of your money."

Additional production will be warranted largely by additional information from research and development. Otherwise, the Secretary said, "We might very well find our shelves cluttered up with unuseable duds—a drug on the weapons market and a drag on our defense resources."

Secretary McElroy repeated that he did not intend to be pressured into spending tax dollars on unproved programs.

SAC Crews Start *Atlas* Training

Phase One or "factory" training began last month for Air Force crews to be assigned to *Atlas* ICBM stations of the Strategic Air Command. Some of the military personnel will man operational bases—others will be assigned as instructors to aid in crew training.

The program is being conducted by Convair Astronautics, through customer training section of the product support department. Also lending a hand is the Air Training Command and SAC.

Phase One is the first of two major training steps. Phase Two, also called "integrated weapons system training," will be offered at Vandenberg AFB, Calif., new SAC ballistic missile training center (m/r., Aug. 25, p. 20).

Personnel for the first classes at Convair-Astronautics have been drawn from Air Force Supervisors and planners for an overall course in the weapons systems. Each course will run three weeks and additional courses are scheduled into 1960.

When the major training effort begins later this year, students will be selected from Air Force specialists in hydraulics, fuel systems, instrumentation and about two dozen other categories. All classes will be small with a maximum of about 10 students. Most of these groups will study for a period of three to six months in San Diego.

Study will be divided between the classroom, "on the job" training at the Astronautics plant, and work at the Sycamore Canyon *Atlas* tests site.

Instruction will include actual work with hardware, components and systems. A complete missile with all its checkout equipment will be made available to the classes. Detailed training aids will be used, including "bug" systems which create malfunctions for trouble-shooting experience.

When the initial courses are completed, students will be skilled in specialized tasks and capable of acting as operators in the blockhouses during a launch operation.

During Phase Two training, in which Astronautics will also play a major part, individual specialists will be grouped into crews for additional training until ready for operational assignments.

Curtiss-Wright Starts Solar Energy Program

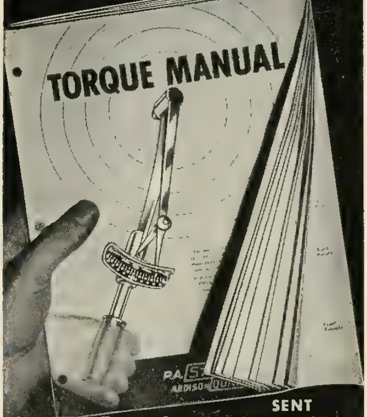
A solar energy program, with emphasis on development and production of commercially salable products based on existing patents and knowledge has been started by Curtiss-Wright Corp., in cooperation with New York University.

The company is now building a "Sun Court" at its Princeton, N.J. division, which will include a solar heated house and batteries, stills, driers, furnaces, cooking equipment, radios and food processing equipment activated by solar energy.

Correct von Braun Moon Rocket Prediction

Somewhat confused trans-Atlantic communications could be blamed for a slight twist in reporting one item from last week's IAF meeting at Amsterdam.

As the story reached m/r's Washington editorial headquarters, Dr. Wernher von Braun was quoted as saying that the Army would launch its moon rocket in October. Left out of the message were these vital italicized words: "I *don't* know *if* we will fire in October. *Certainly* we will fire when we are ready."



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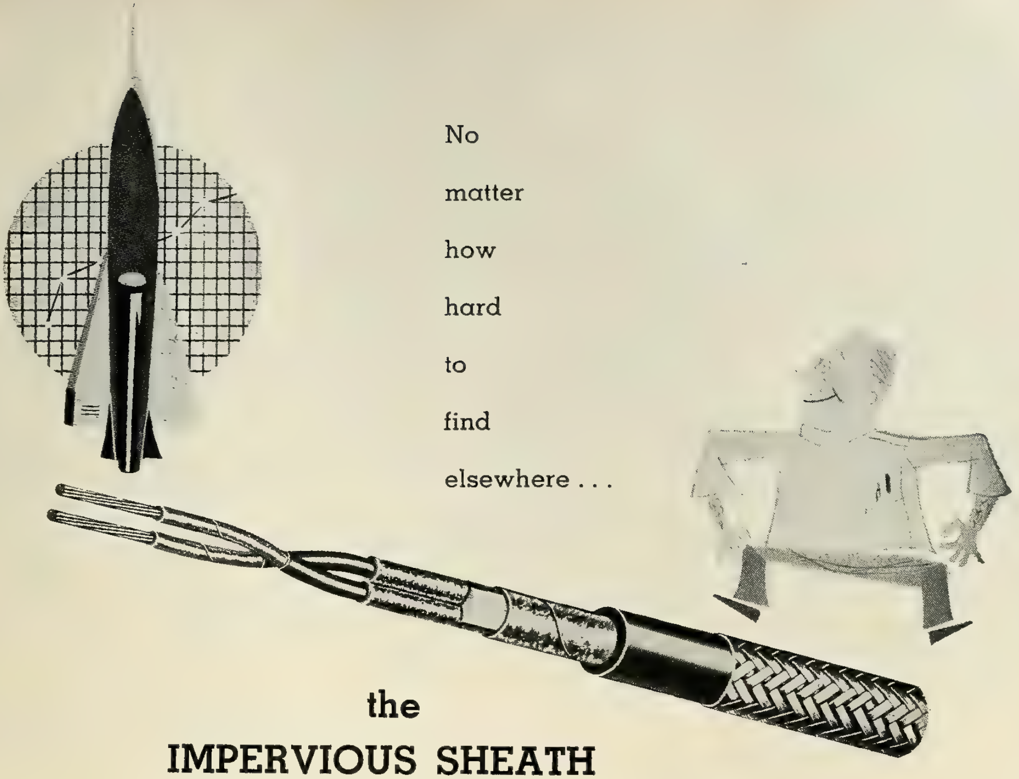

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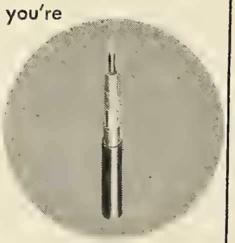

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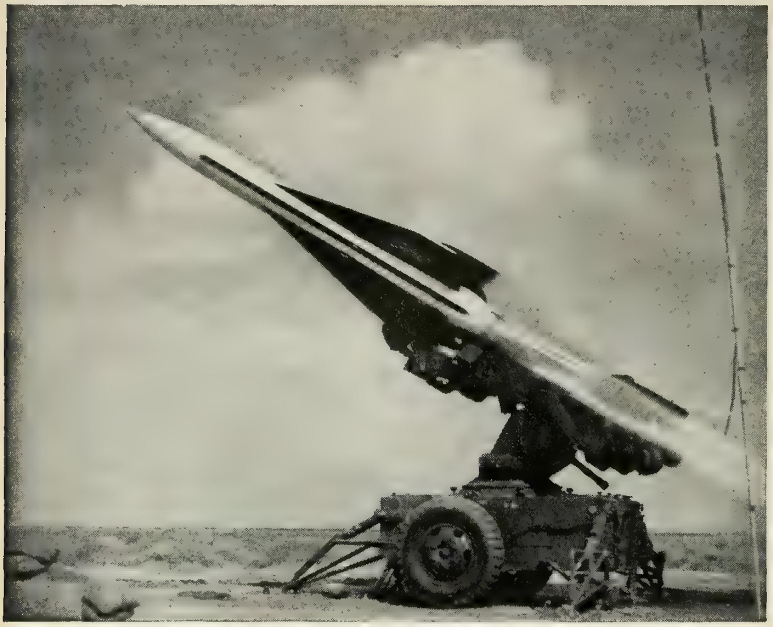

ARMY'S HAWK MISSILE is launched from mobile platform by fast-moving land forces. Raytheon engineers working on prime contract developed the design that makes possible missile's extremely low-altitude capabilities.

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It's your move. Your experience as a specialist in aeronautical design work qualifies you for good positions with a number of capable organizations. But somewhere is that special situation that will lead to the rewarding future you want.

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Hot Gas Engine Designed To Speed Space Craft

An engine that would rain hot gases through magnetic fields to propel a space ship once it got beyond earth's pull of gravity has been designed by Republic Aviation Corp. The engine would produce thousands of pounds of thrust for each pound of fuel, as compared with a few hundred pounds of thrust per pound of fuel in present rocket-type engines.

The engine, however, wouldn't have enough initial quick power to lift a space ship off the ground and push it through the earth's gravitational field, Republic said. This job would be done by chemical fuel rockets.

This engine is the latest device in the growing field of magnetohydrodynamics, or MHD. MHD processes make use of the fact that when a gas is heated beyond a certain temperature, it becomes electrically charged and can be controlled by magnetic fields. However, scientists think it will be at least five to ten years before MHD will be pushing vehicles through space.

Soviets Continue Launch Of Atmosphere Rockets

The Soviet Union has launched a total of 36 meteorological rockets for upper atmosphere research during the period of November 1957 to May 1958, it has been reported in the Soviet press.

The launchings have been made from the Soviet IGY station at Franz Joseph land in the Arctic, and the Soviet expedition ship "Ob." The "Ob" has been cruising in the southern latitudes and has fired off the coast of East Antarctica; in the vicinity of Snares Islands, N.Z.; in the Tasman Sea; the Ross Sea; and in the meridianal sector from Bellingshausen Sea to Easter Island.

Engineers In Demand By Electronic Firms

As defense contracts mount, electronic firms are snapping up engineer graduates at rapid rates. Every one of last year's 33,000 engineering graduates has had at least one job offer, reports New York's Engineers Joint Council.

Salaries offered range from around $7,000 for less experienced men to $18,000 for senior specialists. Extra inducements are being offered by some companies . . . such as taking a prospective employee's house off his hands if he is offered a job in a distant locality. Pirating . . . raiding a competitor's staff . . . is on the rise again.

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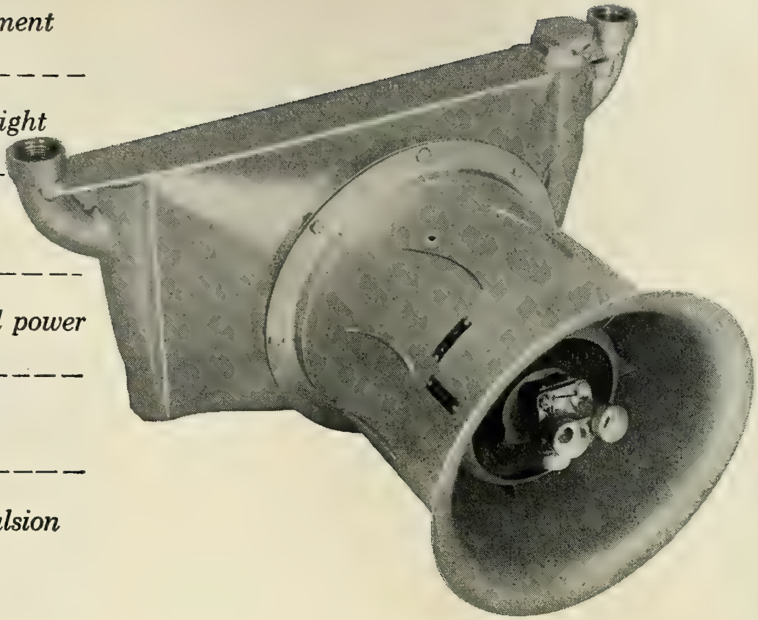

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VTOL developments and the various types and models of helicopters have requirements for cooling air that cannot be provided by a ram air source immediately available in other types of aircraft.

The UAP system illustrated above consists of a plate type air-oil cooler, vane axial blower and an integral hydraulic motor. The assembly has application to VTOL and helicopters where it does a remarkable job of cooling hydraulic oil systems even in static flight attitudes.

For complete information call the nearest UAP Contractual Engineering Office

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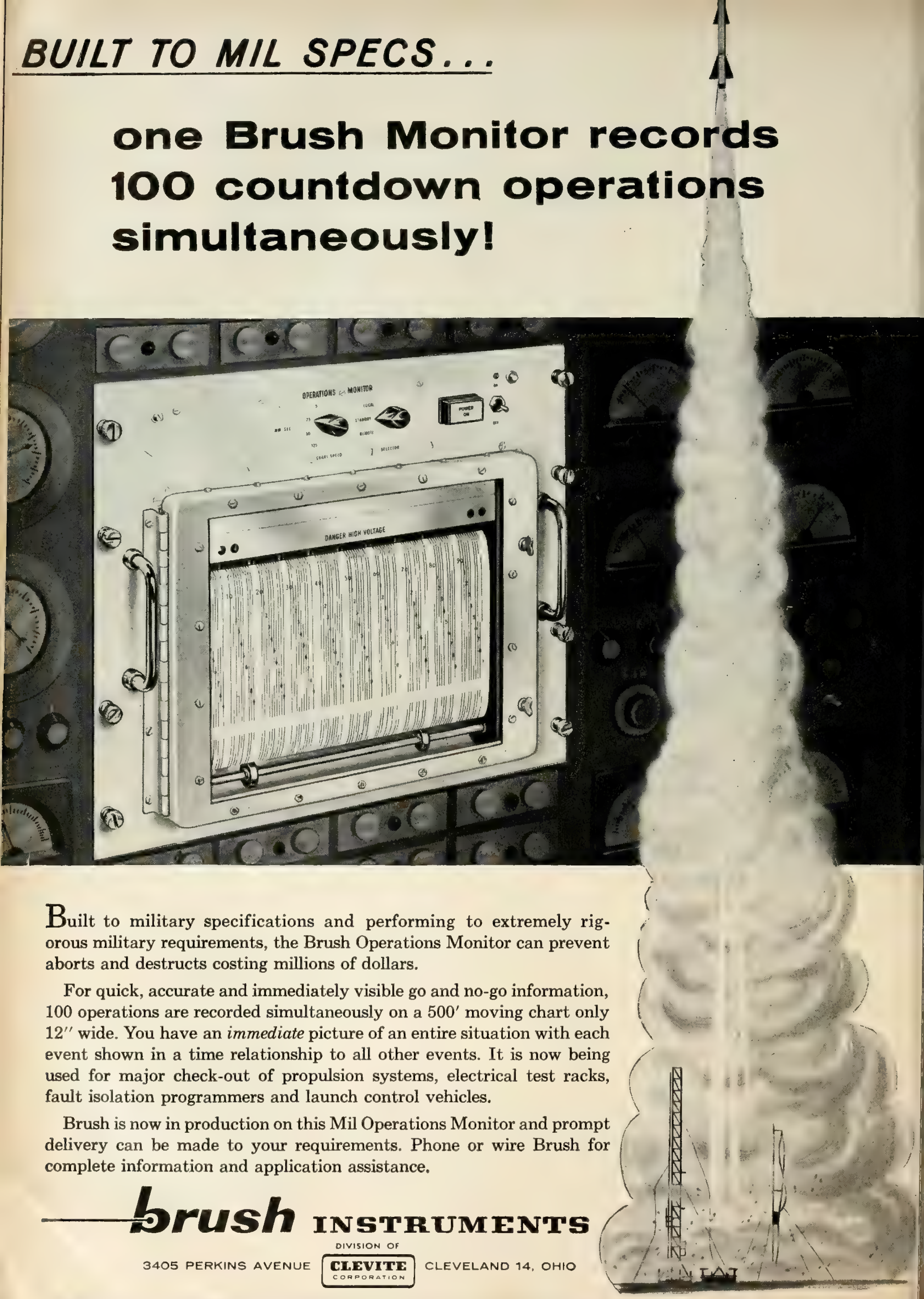

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Wires and Cables: Vital To Missiles

Here is the latest on the machines that make them, evaluate them, and units that connect them.

by Peer Fossen
and
Raymond M. Nolan

In this special report to its readers, m/r describes a group of new developments in the wire and cable field. Teflon, reviewed here in detail, may become the most widely used insulation product for missile wiring.

The Automatic Cable Evaluator is a good example of sequential checkout equipment which will become more and more important as deterrent missiles move into the solid propellant, instantly available generation. The cabling machine described is a notable advance in wiring assembly, since it means that cables can now be fabricated on location at firing sites.

The "Poke-Home" connector with its solderless connection and assembly of wires to contacts is another product reviewed.

On pages 30 and 31, a survey of some representative products in the printed cabling field is presented in a two-page table.

Teflon

Current developments in electrical lesign call for more and more miniaurization, resistance to higher and igher temperatures, and better dielecric properties. Often all three are required at once. Many of these difficult lesign problems are being solved with he help of Du Pont Company's Teflon luorocarbon resins, and their excepional combinations of properties.

• **General properties**—Much of the uccess of products made of Teflon TFE-fluorocarbon resins results from a ombination of properties that is not o be found in other engineering maerials.

- Exceptional thermal stability (from −450°F. to +500°F.).
- Outstanding electrical properties.
- Lowest coefficient of friction of any solid (0.04).
- Almost universally chemically inert.
- High flex life.
- Excellent impact strength.
- Unaffected by outdoor weathering.
- Essentially zero water absorption (less than 0.01% by A.S.T.M. test).

• **Important electrical properties**—*ligh Dielectric strength*—Short-time dilectric strengths are high, and are unaffected by aging at high temperatures. The dielectric strength of any material varies inversely with the thickness. For materials made of Teflon TFE-fluorocarbon resins, these values range from 4000 volts per mil in ¼ mil film to 400 volts per mil in thickness of ¼ inch and greater.

Flat Dielectric Constant and Dissipation Factor—Both the dielectric constant and dissipation factor of parts made of Teflon resins change less over a wide range of temperature and frequencies than do the corresponding values for any other solid. They are absolutely constant from below 60 cycles to above 10,000 megacycles (the spectrum measured to date), and are unaffected by time or heat aging. Because of the low dissipation factor at all frequencies, Teflon resins make the best dielectrics for high-power pulse-forming networks such as those used in radar transmitters, which operate as high as 25,000 volts.

High Surface Arc Resistance—The surface arc resistance of materials made of Teflon resins is high. When subjected to a surface arc, insulation of a Teflon resin will not crack or form a carbonized conducting path. This feature enabled electrical engineers to solve a long-standing problem in traction motors where brush holders of the best epoxy resins failed in less than a month. Now brush holders insulated with a Teflon resin provide dependable performance with no failures caused by surface arc.

High Insulation Resistance—Both the volume and surface resistivity of parts made of Teflon resins are high, and are unaffected by time or high temperatures. The volume resistivity is greater than 10^{18} ohm-cm., even after prolonged soaking in water. Equally as good, the surface resistivity is 10^{17} ohms per sq., even at 100% relative humidity. When tested for six months at 250°C., both the surface and volume resistivity were completely unaffected.

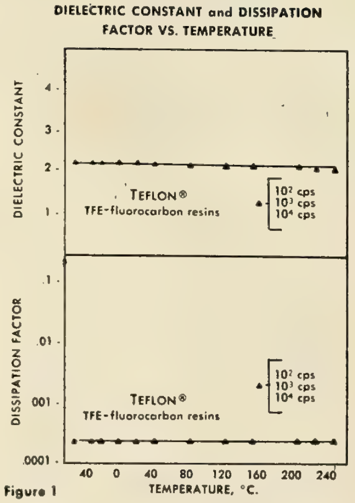

Figure 1

• **Special design considerations**—Actual use surveys show that in many cases, parts made of Teflon resins are specified to take advantage of special design possibilities in addition to their excellent electrical properties.

Ease of Fabrication—Miniaturization and complex electrical systems

CABLE

- Advanced Electronics, Inc.
- Aerolite Electronics Corp.
- Aeronautical & Instrument Div., Robertshaw-Fulton Controls Co.
- Alden Products Co.
- All American Aircraft Products, Inc.
- Alpha Wire Corp.
- Aluminum Co. of America
- Amelco, Inc.
- American Electric Cable Co.
- American Insulated Wire Co.
- American Steel & Wire Div., U.S. Steel Corp.
- American Super Temperature Wires Inc.
- Anchor Specialty Mfg. Co. Inc.
- Andrew Corp.
- Ansonia Wire & Cable Co., The
- Associated Co., Inc.
- Aviation Developments Inc.
- Barker Sales Co.
- Belden Mfg. Co.
- Bergen Wire Rope Co.
- Berkshire Electric Cable Co.
- Birnbach Radio Co., Inc.
- Bliss Electronic Corp.
- Boston Insulated Wire & Cable Co.
- William Brand & Co., Inc.
- California Technical Industries
- Cambridge Wire Cloth Co., The
- Chester Cable Corp.
- Coaxial Connector Co. Inc.
- Consolidated Radio Products Co.
- Consolidated Wire & Associated Companies
- Cooper Development Corp.
- Copperweld Steel Co., Wire & Cable Div.
- Dale Products, Inc.
- Dayton Aircraft Products, Inc.
- Dwyer Engrg. Co., Inc.
- Dynamic Gear Co., Inc.
- Elco Corp.
- Electric Auto-Lite Co., The, Wire & Cable Div.
- Electric Parts Corp.
- Elgin Micronics, West Coast Div.-Elgin National Watch Co.
- Empire Electronics Co., Inc.
- Essex Wire Corp.
- First Electronics Corp., The
- Food Machinery & Chemical Corp., Ordnance Div.
- General Cable Corp.
- General Electric Co., Missile & Ordnance Systems Dept.
- Greenleaf Mfg. Co., The, Div.-Mandrel Industries
- Hallamore Electronics Co.
- Hallett Mfg. Co.
- Hammett Electric Co.
- Harco Labs., Inc.
- Hitemp Wires, Inc.
- Hoover Electronics Co.
- Industrial Television Inc.
- Industrial Wiring & Cable Co.
- International Electric Industries, Inc.
- Jefferson Products Co.
- Kahn & Co., Inc.
- Key Resistor Co.
- Kilgen Aircraft Div., The Kilgen Organ Co.
- La Pointe Industries Inc.
- Lane Electronics Mfg. Corp.
- Lewis Engrg. Co., The
- Lytle Engrg. & Mfg. Co.
- Miljan Div., Paul Omohundro Co.
- Minneapolis-Honeywell Regulator Co., Aeronautical Div.
- Missile Engrg. Products, Inc.
- Mohawk Wire & Cable Corp.
- Mutron Corp.
- National Standard Co.
- New England Electrical Works, Inc.
- Normandy Electric Wire Corp.
- Organic Development Corp., Spectra-Strip Div.
- Pacific Automation Products, Inc.
- Phelps Dodge Copper Products Corp.
- Plastoid Corp.
- Precision Tube Co., Inc.
- Prodelin Inc.
- Pyle-National Co., The
- Reid Metal Products, Inc.
- Resdel Engrg. Corp.
- Rex Corp., The
- Rockbestos Products Corp.
- John A. Roeblings Sons Corp.
- Rome Cable Corp.
- Rowe Industries
- Royal Electric Corp.
- Schaffer Air Industries, Inc.
- Scintilla Div., Bendix Aviation Corp. Sealectric Switch & Relay Corp.
- Sequoia Wire Co.
- Southwest Products Co.
- Southwestern Industrial Electronics Co.
- Surprenant Mfg. Co.
- Technical Appliance Corp.
- Telectro Industries Corp.
- Teleflex Inc.
- Teletronic Labs., Inc.
- Terminal Radio Corp.
- Thermax Wire Corp.
- Thompson Products, Inc.
- Times Wire & Cable Co., Inc.
- Tri-Dex Co.
- Tucson Instrument Corp.
- Twix Mfg. Co., Inc.
- Uniwave, Inc.
- Victor Electric Wire & Cable Corp.
- Warren Wire Co.
- Wells Industries Corp.
- Western Insulated Wire Co.
- Western International Co.
- Westronics Inc.
- Westwood Cable Corp.
- Wickfield, Inc.
- Wilmar Mfg. Co., Inc.
- Winder Aircraft Corp. of Fla.
- Wire Co. of America, Inc.
- Wunderlich Radio Co.
- Zippertubing Co., The

CABLE ASSEMBLIES

- AC Spark Plug Div. General Motor Corp.
- ACF Industries, Inc., Advanced Products Div.
- Advanced Electronics, Inc.
- Aerolite Electronics Corp.
- Aeronautical & Instrument Div., Robertshaw-Fulton Controls Co.
- Alden Products Co.
- All American Aircraft Products, Inc.
- Alphs Wire Corp.
- Amelco, Inc.
- American Electric Cable Co.
- American Electronic Labs., Inc.
- American Machine & Foundry Co.
- American Super-Temperature Wires, Inc.
- Anchor Specialty Mfg. Co. Inc.
- Arens Controls, Inc.
- Associated Co., Inc.
- Beldon Mfg. Co.
- Bergen Wire Rope Co.
- Berkshire Electric Cable Co.
- Birnbach Radio Co., Inc.
- Bliss Electronic Corp.
- William Brand & Co. Inc.
- California Technical Industries, Div.-Textron Inc.
- Centronix Inc.
- Coaxial Connector Co. Inc.
- Consolidated Wire & Associated Companies
- Cooper Development Corp.
- Cromer Mfg. & Engrg., Inc.
- Dale Products, Inc.
- Dwyer Engrg. Co., Inc.
- Elco Corp.
- Electric Parts Corp.
- Electronic Assembly Co., Inc.
- Electronics Dept., Hamilton Standard Div. United Aircraft Corp.
- Elgin Micronics, West Coast Div., Elgin National Watch Co.
- Empire Electronics Co., Inc.
- Essex Mfg. Co., Inc.
- First Electronics Corp., The
- Food Machinery & Chemical Corp., Ordnance Div.
- General Railway Signal Co.
- Greenleaf Mfg. Co., The, Div.-Mandrel Industries Inc.
- Guardian Electric Mfg. Co.
- Hallamore Electronics Co.
- Hallet Mfg. Co.
- Hammett Electric Co.
- Harco Labs. Inc.
- Hi-Lo Manufacturing Corp.
- Hitemp Wires Inc.
- Hooner Electronics Co.
- Industrial Wiring & Cable Co.
- International Electric Industries, Inc.
- Walter K. Jaros, Aircrafts
- Kahn & Co., Inc.
- Kaiser Aircraft & Electronics Div.-Kaiser Industries Corp.
- Kilgen Aircraft Div. The Kilgen Organ Co.
- La Pointe Industries Inc.
- Lane Electronics Mfg. Corp.
- Lewis Engrg. Co., The
- Lytle Engrg. & Mfg. Co.
- Machine Engrg. Co., Inc.
- J. A. Maurer, Inc.
- Methode Mfg. Corp.
- Minneapolis-Honeywell Regulator Co., Aeronautical Div.
- Missile Engrg. Products, Inc.
- J. J. Monaghan Co.
- Mutron Corp.
- Network Mfg. Corp.
- Normandy Electric Wire Corp.
- Organic Development Corp., Spectra-Strip Div.
- Pacific Automation Products, Inc.
- Phaostron Instrument & Electronic Co.
- Philco Corp. Government & Industrial Divs.
- Precision Tube Co., Inc.
- Reeves Instrument Corp.
- Resdel Engrg. Corp.
- Rex Corp., The
- John A. Roeblings Sons Corp.
- Rowe Industries
- Royal Electric Corp.
- Schaeffer Air Industries, Inc.
- Scintilla Div., Bendix Aviation Corp.
- Sealectric Switch & Relay Corp.
- Sequoia Wire Co.
- Shaw Metal Products Corp.
- Sheltered Workshop
- Sittler Corp.
- Sonex, Inc.
- Southwest Products Co.
- Superex Electronics Corp.

call for materials which simplify assembly. Certainly one of the most important assembly and service savings is the ability of insulation of Teflon to withstand solder iron temperatures. Soldering operations can be performed speedily; service failures are reduced, thus lowering inspection requirements; and electricians can carry out maintenance jobs with little or no chance of destroying insulation.

Because Teflon resins have the lowest coefficient of friction of any material, electronic components can be installed quickly and easily in compact assemblies. Miniature feed-thru insulators of a Teflon resin take advantage of this property, together with the good plastic memory. They are stiff but can be deformed enough to be quickly snapped into place. Another example is spaghetti tubing made of Teflon resins, which can be easily slipped over long conductors.

Reliability—Insulation of a Teflon resin is unaffected by soldering iron temperatures, thus improving reliability. Also, Teflon resins contain no plasticizer to cause failure due to brittleness Insulation of a Teflon resin will no heat age, will not oxidize, and will withstand high transient overloads. Mor and more safety devices are bein made, even more reliable with insulation of a Teflon fluorocarbon resin.

Space and Weight Savings—Becaus of the ability of insulation of a Teflo resin to withstand high temperature center conductors can operate at highe temperatures, and accordingly carr much more power for the same cro section than with ordinary insulation For example, at room temperature th substitution of coaxial cable with core of a Teflon resin permits a fo to one weight saving and an eight one space saving for equivalent pow over coaxial cable with a core of pol ethylene. This same principle is a plicable to all types of electrical com ponents. Thus, a complete electric chassis can be reduced in size a weight by the use of Teflon resins.

COAXIAL CABLE SIZE COMPARISO

CODE	CORE DIAMETER	CORE MATERIAL	RELATIV POWER RAT
RG 58 A/U	0.116 in.	Polyethylene	1
RG 188/U	0.06 in.	TEFLON® TFE-fluorocarbon resins	2

Figure 2

Insulation in Extreme Temperatu —In addition to the reliability weight savings realized through use of Teflon resins in high ambi temperatures, there are many requirements for an insulation that will perform satisfactorily at temperatures above 500°F for short periods. Particularly important among these are: areas where resistance to fire is needed in emergencies (safety equipment and warning devices); short-lived guided missiles; and insulation to withstand high thermal overloads for short periods of time (wiring in motors or generators where unexpected power surges are possible).

Teflon TFE-fluorocarbon resins are able to retain their good insulating properties at temperatures above 500°F for relatively long periods of time. This s possible because of their high melt viscosity and their very low weight loss at high temperatures. Not only are they completely non-flammable, but even at 788°F, they only lose weight at a rate of about 1/10 of a percent per hour.

LIFE AT EXTREME TEMPERATURES

(TFE-Fluorocarbon Resins in Air at Atmospheric Pressure)

TEMPERATURE		WEIGHT LOSS % PER HOUR	ESTIMATED LIFE
500°F.	260°C.	0.00015	Years
600°F.	316°C.	0.0004	Months to Years
700°F.	371°C.	0.002	Hours to Months
800°F.	427°C.	0.15	Minutes to Hours
900°F.	482°C.		Minutes to Hours
1000°F.	538°C.		Minutes

gure 3

Cable Evaluator

James Cunningham, Son & Co., nc., Rochester, New York, recently put n the market a new Automatic Cable Evaluator. The new unit, named SPACE Self-Programming Automatic Cable Evaluator), is a console-mounted testing instrument which automatically hecks for leakage (hi-pot) and continuity between any and all wire ends r terminations of a cable harness or evice being tested. SPACE, employing computer type memory, progresses hrough a series of tests in a logical manner at a maximum rate of 10 tests er second and has a capability of enerating its own tape program.

The unit includes two scanning circuits, a tape reader and code storage nit, a motorized tape punch, output rinter and leakage and continuity detection circuitry. Decision circuits are rovided to channel information from e testing functions. The scanners employ Cunningham Type F Crossbar witches.

• **Working operation**—In the "analyzer" mode, a sample chassis or harness is connected to SPACE through venty 24-terminal Amphenol Blue

Surprenant Mfg. Co.
Technical Appliance Corp.
Telectro Industries Corp.
Teleflex Inc.
Teletronic Labs., Inc.
Terminal Radio Corp.
Thermax Wire Corp.
Times Wire & Cable Co., Inc.
Transco Products, Inc.
Transvision, Inc.
Tricraft Products Corp.
Tri-Dex Co.
Tucson Instrument Corp.
Twix Mfg. Co., Inc.
Victor Electric Wire & Cable Corp.
Warren Wire Co.
Wells Industries Corp.
Westbury Electronics Inc.
Western International Co.
Westronics Inc.
Westwood Cable Corp.
Wheeler Electronic Corp., Sub.-Sperry Rand Corp.
Wickes Engrg. & Construction Co. Inc.
Wickfield, Inc.
Wilmar Mfg. Co., Inc.
Winder Aircraft Corp. of Fla.
Wire Co. of America, Inc.
Zippertubing Co., The

WIRES

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Accurate Insulated Wire Corp.
Advanced Electronics, Inc.
Aerolite Electronics Corp.
Aeronautical & Instrument Div., Robertshaw-Fulton Controls Co.
Alden Products Co.
Allied Plastics Supply Corp.
Allied Research & Engrag., Div. Allied Record Mfg. Co.
All-State Welding Alloys Co., Inc.
Alpha Wire Corp.
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Cambridge Wire Cloth Co.
Carpenter Steel Co.
Chase Brass & Copper Inc.
Chester Cable Corp.
Coaxial Connector Co. Inc.
Consolidated Wire and Associated Companies
Cooper Development Corp.
Co-Operative Industries Inc.
Copperweld Steel Co. Wire and Cable Div.
Cuno Engrg. Corp.
Dale Products Inc.
Dayton Aircraft Products Inc.
Delta Chemical Works Inc.
Wilbur B. Driver Co.
Dwyer Engrg. Co. Inc.
Eastern Smelting and Refining Corp.
Eisler Engrg. Co. Inc.
Elco Corp.
Electric Auto-Lite Co.
Electric Parts Corp.
Electronics Dept., Hamilton Standard Div., United Aircraft Corp.
Elgin Micronics, West Coast Div., Elgin National Watch Co.
Elmet Div., North American Philips Co. Inc.
Empire Electronics Co.
Enflo Corp.
Engelhard Industries Inc., D. E. Makepeace Div.
Essex Wire Corp.
Fansteel Metallurgical Corp.
First Electronics Corp.
Fort Wayne Metals Inc.
General Cable Corp.
General Laboratory Associates Inc.
Goldsmith Brothers Smelting and Refining Co.
Gray Mfg. Co.
Greenleaf Mfg. Co., The Div. Mandrel Industries Inc.
Gunnar Laboratories
Hackensack Cable Corp.
Hallett Mfg. Co.
Hammett Electric Co.
Harco Labs.
Haynes Stellite Co. Div. Union Carbide Corp.
Highland Engrg. Co.
Hitemp Wires Inc.
Hoover Electronics Co.
Hudson Wire Co.
Industrial Wiring and Cable Co.
International Electric Industries Inc.
International Wire and Cable Co.
Walter K. Jaros, Aircrafters
Jefferson Products Corp.
Johnston and Funk Titanium Corp.
Kahn and Co. Inc.
Key Resistor Corp.
Kilgen Aircraft Div. The Kilgen Organ Co.
Kulka Electric Corp.
La Pointe Industries Inc.
Leach and Garner Co., Industrial Div.
Lewis Engrg. Co.
Lumen Inc.
Lytle Engrg. and Mfg. Co.
Magnetic Shield Div., Perfection Mica Co.
P. R. Mallory and Co. Inc.
Mallory-Sharon Metals Corp.
Manger Electric Co.
Menaugh Co.
Metals and Controls Corp.
Micro-Wire Tungsten and Molybdenum Products
Miljan Div. Paul Omohundro Co.
Missile Engrg. Products Inc.
Modelectric Products Corp.
Mohawk Wire and Cable Corp.
Monaghan Co.
National Standard Co.
New England Tape Co. Inc.
Ney Co.
Normandy Electric Wire Corp.
North Electric Co.
Organic Development Corp., Spectra-Strip Div.
Packard Electric Div. General Motors Corp.
F. H. Paul and Stein Brothers, Inc.
Philco Corp., Government and Industrial Div.
Plastoid Corp.
Harold H. Powell Co.
Precision Tube Co.
Progressive Research and Development Co., Inc.
Radix Wire Co.
Rex Corp.
Republic Steel
Rockbestos Products Corp.
Roebling's, John A. Sons Corp.
Rome Cable Corp.
Rowe Industries
Royal Electric Corp.
Sanders Associates, Inc.
Schaffer Air Industries Inc.
Scintilla Div., Bendix Aviation Corp.
Secon Metals Corp.
Sequola Wire Co.
Servicair Co.
Sheltered Workshop
Sittler Corp.
South River Metal Products Co. Inc.
Standard Metals Corp.
Superex Electronics Corp.
Sylvania Electric Products Inc., Parts Div.
Surprenant Mfg. Co.
T-C Div., Dyna-Empire, Inc.
Terminal Radio Corp.
Thermax Wire Corp.
Times Wire and Cable Co. Inc.
Titan Metal Mfg. Co.
Titeflex, Inc.
Topper Mfg. Co. Inc.
Transvision, Inc.
Tucson Instrument Corp.
Victor Electric Wire and Cable Corp.
Warren Wire Co.
Washington Aluminum Co.
Western Gold and Platinum
Western Insulated Wire Co.
Western International Co.
Westwood Cable Corp.
Wickfield Inc.
Winder Aircraft Corp. of Fla.
Zippertubing Co.

CONNECTORS

Aerolite Electronics Corp.
Aircom Inc.
Airtron, Inc.
Airwork Corp.
Alden Products Co.
Allied Plastics Supply Corp.
Anton Electronic Labs., Inc.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Auburn Spark Plug Co. Inc.
Automatic & Precision Mfg. Co.
Avnet Corp.
Birnbach Radio Co., Inc.
Blonder-Tongue Labs., Inc.
Burndy Corp., Omaton Div.
Cal-Ohm Labs. Inc.
Cannon Electric Co.
Circon Component Corp.
Cleveland Metal Specialities Co.
Coaxial Connector Co. Inc.
Columbia Research Labs.
Connector Corp.
Continental Connector Corp.

Due to space limitations, m/r is unable to complete the list of connector manufacturers in this issue. These manufacturers will be listed in a future issue.

What's new in TITANIUM welding:

Resistance and fusion welding as fabrication procedures have become increasingly important with the advent of missiles and aircraft designed for sustained operation at Mach 3 and better.

Titanium alloys are available which provide fusion-weld efficiencies of 100 percent, and spot-welded joints with excellent load carrying capacities.

Through its new Toronto, Ohio, rolling mills —designed specifically for titanium operations —Titanium Metals Corporation of America can provide light-gage flat-roll weldable products of consistently highest quality, on the fastest delivery schedules, at the lowest possible price in the industry today.

Q. What are the leading welding grades?

A. Ti-75A, a single-phase unalloyed grade which is readily formable; Ti-5A1-2.5Sn, a single-phase alloy grade which provides excellent resistance to oxidation up to 1200°F; and Ti-6A1-4V, a duplex-phase alloy grade with guaranteed minimum tensile strengths to 130,000 psi. Guaranteed minimum mechanical properties of these grades are:

GRADE	DENSITY lb/cu in	Guaranteed Room Temperature Properties		
		0.2% YS	UTS	Elong, % in 2"
Ti-75A	0.163	70,000	80,000	20
Ti-5A1-2.5Sn	0.162	110,000	115,000	10
Ti-6A1-4V	0.161	120,000	130,000	10

Q. Are special precautions required for welding these grades?

A. Titanium is spot-welded more readily than aluminum and many of the carbon and low alloy steels, and requires no special precautions. Spot-weld machine settings used for titanium and stainless steel are very similar.

Titanium is fusion-welded with inert-gas-shielded arc welding techniques and joint designs which are also similar to those used for other metals. Two fundamental principles must be considered:

1. Coated electrodes and other fluxing compounds cannot be used.
2. Titanium weld joints must be shielded from the normal atmosphere with an inert blanket of argon or helium during welding.

Q. Does that mean chambers are mandatory for fusion weldng?

A. No. Open air welding is adaptable to production operations when both root and face of the weld are protected from the air. Small parts and complex shaped weldments which are difficult to shield adequately may still be welded more easily and economically inside a chamber. This is described in detail in TMCA's publication, *Titanium Welding Techniques,* Engineering Bulletin #6.

Successful titanium welding techniques have enabled fabricators to produce missile propellant storage bottles which resist internal pressures of 8000 psi at —300°F. This all-titanium bottle, produced by Rheem Manufacturing Company, Downey, Calif., is Ti-6Al-4V, fusion-welded in an argon atmosphere. Designers say use of titanium bottles can add up to 700 miles to the range of an IRBM.

Q. Are titanium welds more susceptible to corrosion attack than the base metal?

A. Titanium welds offer the same excellent corrosion resistance as the base metal. Stabilizing heat-treatments, employed with many other materials, are *not* required.

Successful welding is a key factor in today's designs. It enables designers to draw upon titanium's unique combination of properties: light weight, corrosion resistance, and ability to withstand operating temperatures from −300°F to 1000°F — for the added performance vital to these uniquely critical times.

Titanium Metals Corporation of America has just completed the first comprehensive study of welding techniques yet published by the industry. This 32-page publication draws upon metallurgical considerations to recommend and explain techniques required for quality titanium weldments.

Titanium Welding Techniques, as well as other publications, in the most extensive data library in the industry, is available from Titanium Metals Corporation of America, 233 Broadway, New York 7, New York. This important literature is yours for the asking.

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- ☐ Bulletin 2 Heat-Treatability of Ti-6Al-4
- ☐ Bulletin 3 Analytical Chemistry of Titanium
- ☐ Bulletin 4 Mechanical Testing of Titanium
- ☐ Bulletin 5 Properties of Ti-155A
- ☐ Bulletin 6 Titanium Welding Techniqu
- ☐ Other ....

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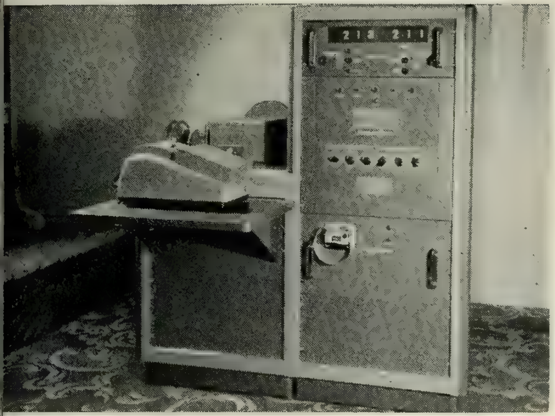
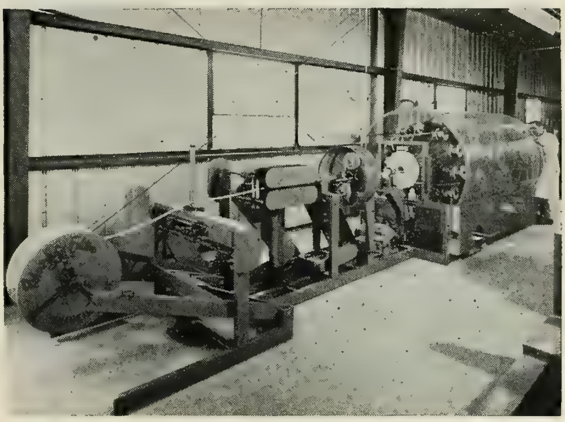


**HE SPACE CABLE EVALUATOR shown here has a capac-
y of 420 terminations. Space, however, can be supplied with
eater or smaller termination capacities.**



ADVANCED CABLING EQUIPMENT employed at Robertshaw's "cable systematics" facility is typified by this new custom built cabling machine.

ibbon connectors. This chassis is then
anned through all possible combina-
ons, and holes are punched in the
pe for those combinations in which
ntinuity is found. The tape which re-
lts from this scanning operation then
ecomes the test program, and is sub-
quently used for verification of other
milar chassis.

In the "verifier" mode, another
assis to be tested is connected to the
st equipment, the tape is inserted in
e tape reader and the first frame,
ntaining the coordinates of the first
ort, is read into a temporary storage
nsisting of another Type F crossbar
vitch. All of the possible combinations
e then again scanned automatically.
or combinations where leakage is
und, a separate test is automatically
ade for continuity.

If continuity is found, a comparison
made with the contents of the tem-
orary storage, and if the coordinates
orrespond to that in storage, the short
accepted as being intended. If either
akage or an unintended short are
und, the coordinates and nature of
e discrepancy are printed out and dis-
layed on a visual in-line readout
evice. Scanning is then resumed either
utomatically or at a manual com-
and depending on the position of
e "manual-automatic" switch. The
unched-tape advances whenever tests
e completed between the pair of co-
rdinates in storage.

For each chassis or harness tested,
printed record will thus be provided
utomatically to indicate the co-
rdinates of the test discrepancy to-
ether with the letter L, S, O, or R to
dicate leakage, short, open or re-
stance respectively.

A seven-hole biquinary code with an
th "clear" code is used on the one
inch wide paper tape. Tape is initially stored on the reel associated with the punch, and when transferred to the reader is folded in a Lucite container in a closed loop.

• **Handling operation**—The entire instrument is housed in an Emcor console, 40 inches wide, 52 inches high and 25 inches deep. The tape handling and printing units are mounted at seating level. The Amphenol Blue Ribbon connectors are brought out at the back of the analyzer for convenient access to the equipment under test. All chassis are mounted on slides for easy access and removal from the back of the console. Only operational controls are mounted on the front of the console.

Integrated Cable-making

Representing an entirely new approach in the fabrication of custom electronic cable, a unique "integrated" cable making-facility is now fully operational at Robertshaw-Fulton Controls Company, Aeronautical and Instrument Division, Anaheim, California.

Employment of integration techniques, called "cable systematics," is intended to bring custom electronic cabling into line with the advanced nature of present-day electronics and systems development. This will meet the challenge indicated by statistics, which show an alarming percentage of missile failures attributable to faults and breakdowns in electronic cabling and cable systems.

According to company officials, the new facility is the logical result of Robertshaw's requirements for greater precision, reliability and applicational adaptability in cabling as an integral and vital element in the development of systems and components involving electronics.

Built around a nucleus comprising some of the nation's outstanding cabling experts, the Robertshaw facility is fully staffed for the development and manufacture of all types of complex electronic cable for airborne systems and ground support applications.

• **Machine design**—At the heart of Robertshaw's "Cable systematics" are two completely self-contained cable-making machines of advanced design. Essentially, the philosophy which dictated the design of the new machines has been to produce cable of virtually any size, type and complexity; in long and short runs; at lower cost and in less time.

Technical problems and requirements which approached almost unforeseen proportions were met and solved in the new cabling equipment. Among these were requirements for extremely high and extremely low cabling speeds; short coupling (amount of conductor-wire necessary to thread the machines); adaptability to large and small conductor spools; as well as large or small numbers of conductor spools.

Another requirement involved adaptability to bulky spools containing large-diameter conductors and very small spools containing spider-like coaxials or delicate, shielded members. In addition, balanced planetary action was necessary throughout—to avoid the possibility of stresses and kinks which might change the electrical characteristics of the conductors.

• **Cable design**—Objectives in the

unexcelled as a refrigerant, as an inerting agen

Pureco CO_2 in liquid or solid form is a convenient, low cost, maintenance-free refrigerant of unlimited capacity, which can be accurately controlled for use in low temperature testing and field conditioning.

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able itself included: extreme flexibility, niformity and balance throughout, nd maintenance of specified electrical haracteristics under environment exremes. Manufacturing versatility was ecessary to meet requirements for 1) able of either large or small diameter, ontaining large or small numbers of onductors, 2) fulfillment of specificaions requiring mixed types of conuctors balanced into a single cable or able system, 3) production orders inolving extremely short or extremely ong runs, 4) rapid production of comlex cable to meet urgent time requirenents.

The newest Robertshaw's cablemakng machine, a compact self-contained nit, is designed so that bobbins are asily interchangeable. This permits onfigurations to be changed rapidly o conform to succeeding project reuirements for any type of complex able.

In addition, a special caterpillarraction capstan will grip any wire rom .025" to 3" diameter, and autonatically adjust traction pressure in acordance with the characteristics of the able and the drag. The machine is deigned for speeds ranging from a low 1' er minute to a high of 480' per minite, within a normal "cruising range."

The equipment is engineered to roduce an exceptionally flexible lay, vhich is achieved through a highly preise contrahelical build-up and use of short pitch ratio. Cables are planned nd conductors are laid so that the maller, more delicate members are rotected from crush and stress by he larger members.

As a result of this balanced-engineering concept, the resulting cable and its component members are both statically and dynamically balanced throughout, so that primary objectives of high reliability and consistency of quality are met. Both cabling machines have high reproducibility factors that are particularly valuable in producing short-run samples for prototype use. This may then be followed by production runs meeting the exact specifications of the pilot run.

There is little question, that with previously-existing machinery and manufacturing techniques, it would be difficult if not impossible to produce complex electronic cable meeting the requirements and standards achieved at Robertshaw-Fulton.

• **Overall planning**—In addition to the manufacturing requirements and objectives already discussed, an important phase of precision cabling is the initial cable planning and cable engineering. At Robertshaw, each job is handled as a custom project. Engineering requirements are analyzed, drawings are checked or new drawings made, and the cable "lay" or build-up is carefully designed in order to assure a uniform, high-quality cable which fully meets all projected requirements.

To further assure final reliability, complete facilities are available for tests involving environmental extremes —such as impact and abrasion resistance, crushing, bending, twisting and electrical connection verification. Additional facilities are available to check for shorts and changes in electrical characteristics of cable items under test.

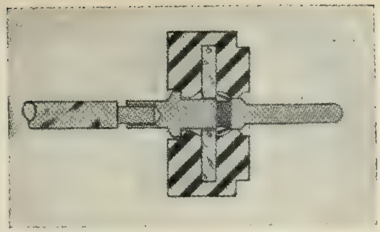
"Poke-Home" Connector

How many missile fizzles have been caused by faulty electrical connections and malfunctioning connectors? No one will ever know for sure, but as the complexity of electronic components and systems increases, the number of connections skyrocket. The points at which wires, cables, and "black boxes"—for the sake of convenience or necessity—have to be disconnected are on the order of thousands.

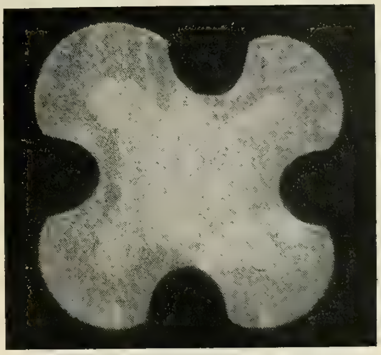
By virtue of the great number of connections alone, the connectors going into a missile system have had to take the blame for numerous aborted missions. Add to this the tough environments in which these connectors must function—extreme temperature ranges, high altitudes, and excessive vibration—and it becomes quite evident why the connector art is in a perpetual state of improvement and new developments.

• **Where error occurs**—To find out what part of the connector is the largest source of potential unreliability, the search centers on those parts containing the largest possibility for human error. Discussions of this facet with any persons responsible for the wiring of missiles and ground support systems will invariably lead to the contacts within the connector, and more specifically, to the attachment of the wire to the contact.

Miniaturization makes connectors get smaller and brings the contacts closer together, and the contacts themselves get smaller because of higher voltage and lower current systems. Consequently, when an assembler solders the wire to the contact, it becomes an operation with many chances for

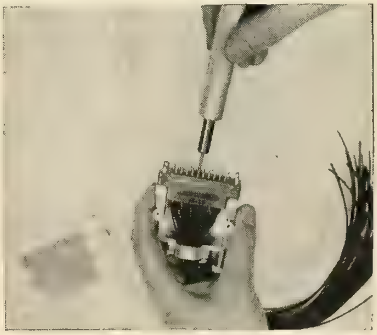


CROSS-SECTIONAL VIEW of the "Poke-Home" contract shows the retaining clip.



THIS "CUT-AWAY" SECTION of the "Poke-Home" highlights the uniformity achieved by Amphenol's new crimping method.

PRIME ADVANTAGE of "Poke-Home" is that the connector can be assembled after the wires are attached to the contacts.



BY USING A SPECIALLY designed tool, the "Poke-Home" contacts can be easily removed for wire repairs or circuit changes.

. . . special report on wires and cables

Manufacturer	American Printed Ckts.	Dwyer Engineering	Miljan Inc. SRP	Miljan Inc. TB	Rowe Engravers	Sanders Associates
1) Type of insulation material	Teflon on glass	Epoxy glass laminate	Silicone-rubber	Teflon	Fluorocarbon	Kel-F
2) Manufacturing process	Printate process	Screen etched and then laminated	Flat conductors are molded in silicone-rubber	Conductors are imbedded in Teflon	Silk screen etched and then laminated	Etched and then laminated
3) Type of conductor material	Copper	Copper	Copper	Silver, silver plated Copper, or tinted copper	1) Silver 2) Copper	Copper
4) Dielectric Strength	1000-2000v/mil (thickness 5-12 mils) short time test	1000-2000v/mil (short time test)	250v/mil (short time test)	1000-2000v/mil (thickness 5/12 mils)	2500v/mil (short time test)	2500v/mil (short time test)
5) Temperature range Minimum Maximum	–195°C 260°C	–50°C 125°C	–73°C 260°C	–195°C 260°C	# 150°C	–60°C 175°C
6) Moisture Absorption	0%	#	.2% (immersion at 25°C)	0%	#	0%
7) Surface Coating Required?	No	No	No	No	No	No
8) Is shielding possible?	Yes (shielding not encapulated)	Yes (if conductors are spaced at least ¼")	No	No	Yes, by putting a grid over the wires and laminating	Yes, by laminating shield
9) Max. cable width available (inches)	Any width	24	2	.25	Any width	14
10) Max. lengths available (inches)	Any length	60	12 to 14	12	Any length	22
11) Current capacity per width of cond.	*	*	*	#	1) * 2) **	*
12) Is branching possible?	Yes	Yes	Yes	No	Yes	Yes
13) Can tap-offs be made?	Yes	Yes	Yes	No	Yes	Yes
14) Pull strength (PSI) before encapulation	10	10	NA	NA	#	8
15) Flexibility (max. bend without base cracking)	Repeated 180° bends	360° 1" diam.	#	#	Repeated 180° bend	2" diam. on 180° bend

NA: Not applicable
#: manufacturer has not obtained information.

* Copper Foil Circuit Overload Ratings

Width (in.)	1 oz. foil (.00135 in. thick) Amps	1 oz. foil (.00135 in. thick) Ohms/in	2 oz. foil (.0027 in. thick) Amps	2 oz. foil (.0027 in. thick) Ohms/in
.250	23	.002	35	.0009
.125	15	.004	20	.0018
.0625	10	.008	15	.0035
.0312	5	.016	8	.007
.0156	3	.032	5	.015

** Silver

Width	Amps
.150	5.0
.050	2.5

(Amount of current which causes a 40°C rise in temp.)

Specifications on Pointed Cables

Manufacturer	Aerovox	Photo Circuits	Methode Mfg. Corp.	Tape Cable Corp.	International Resistance Co.
1) Type of insulation material	Epoxy-fiber glass	1) Phenolic glass 2) Epoxy glass 3) Teflon glass	Silicone	Polyester film insulation	Fluoro-carbon
2) Manufacturing process	Screen etched or photo etched	Silk screen etched (may be etched on both sides of a single base)	Silk screen etched and then laminated	Information withheld pat. pending	Silk screen etched and then laminated
3) Type of conductor material	Copper	Copper	Copper	Copper	Copper
4) Dielectric Strength	750v/mil (short time test)	1) 650v/mil 2) 750v/mil 3) 800v/mil (short time test)	250v/mil	300v/mil	2500v/mil (thickness 1/8" short time test)
5) Temperature range Minimum Maximum	# 175°C	# 1) 125°C 2) 175°C 3) 200°C	# 200°C	–50°C 85°C	# 150°C
6) Moisture Absorption	.2% (24 hours immersion)	1) 1.3% 2) .3% 3) .1% (24 hour immersion)	1.3% (24 hour immersion)	#	0% (24 hour immersion)
7) Surface Coating Required?	Yes	Yes	No	No	No
8) Is shielding possible?	Yes, by laminating but with sacrifice of flexibility	Yes, by laminating shield	Yes, by laminating shield	No	Yes
9) Max. cable width available (inches)	14	12	6	6 approx. 50 conductors	16
10) Max. lengths available (inches)	21	22	11	Any length	16
11) Current capacity per width of cond.	*	*	*	1 amp (all conductors: 1.5 mils thick and 30 mils wide)	*
12) Is branching possible?	No	Yes	Yes	Yes	Yes
13) Can tap-offs be made?	No	Yes	Yes	No	No
14) Pull strength (PSI) before encapulation	10	1) 5-10 2) 5-21 3) 3-9	2-8	#	7-10
15) Flexibility (max. bend without base cracking)	1.75" on 180° bend	Bending cracks the insulation on all three base materials	Cracks when bent sharply	20,000 cycles (sharp 180° bend with no crack)	1.5" diam. on 180° bend

human error. This problem provided the impetus for printed circuits in "black boxes." The equivalent improvement has long been needed where circuits must be made and broken by connectors.

• **New development**—The latest and most advanced addition to the connector field is Amphenol's new series featuring "Poke-Home" contact.

"Poke-Home" offers two very definite advantages; 1) the wire is assembled to the contact by means of an entirely new crimping method, and 2) the assembly takes place outside the connector. After the crimping process, the contact—containing a patented retaining member—is "poked home" in the connector where it is solidly retained.

The crimping of the wire to the contact may be done automatically by machine, or by means of a specially designed hand tool. No. 12, 16, 18 and 20 size contacts can all be crimped by the same tool, and each of these contacts will accommodate several wire sizes. The contact pocket does not have to be altered and a sleeve does not have to be added.

The crimping takes place approximately 1/8 of an inch from the end of the wire pocket, and pressure is applied at four points 90 degrees apart. This assures uniform crimping, and thus uniform connection between each strand of wire and between the wire and the contact itself.

In tests conducted to determine the strength of the crimp (pull test), the wires always broke before they could be pulled from the contact.

The retention forces, after the crimped contact is "poked home," are very high. Forces required to pull the wired contact out of the connector are as follows:

Minimum Retention Forces (Lbs.)

Contact Size	Female Contact	Male Contact
12	18	17
16	20	20
20	12	15

However, by using a special removal tool, the intentional removal of a contact for cable repair or circuit change purposes is accomplished quickly and easily.

"Poke-Home" contact conductivity tests give very good millivolt drop results as shown in the following table.

Contact Size	Test Current DC AMPS	Millivolt Drop MV
12	35.0	6.4 avg.
16	20.0	6.6 avg.
20	7.5	9.2 avg.

• **Current use**—According to the people already using the new "Poke-Home" contact, it provides an uncomplicated answer to eliminating the thousands of points of potential unreliability in connections.

The time and tests required to prove out the validity of this answer were considerable. It took the Amphenol engineers three years of intensive testing and experimentation to obtain the best possible combination of electrical, mechanical, and electromechanical elements in the new contact.

The retaining clip alone required some $150,000 worth of exhaustive engineering design and tests to provide the contact with the required retention when it is assembled, and when it is removed and reassembled many times.

"Poke-Home" contacts are currently used in special connectors being produced for both the *Titan* and *Atlas* missiles. The rack and panel 93 series connectors illustrating this article are employed in the *Bomarc* missile. The 93 series connectors have a temperature range of −65°C. to +200°C. and are rated at 7.5 amps at 500 volts DC at sea level, 7.5 amps at 125 volts DC at 70,000 feet.

An entirely new family of environmentally-resistant, high-temperature "AN"-type miniature and subminiature connectors with "Poke Home" contacts are now nearing production, and are expected to be extensively used in the missile field.

Printed Circuits

The printed cable, which was the subject of a limited survey by m/r, shows definite promise for future missile and space applications.

Printed cables, in themselves, are not a cure-all. Their use entails problems. There are, however, considerable advantages to be gained with the use of presently-available products. The table on pages — and — gives a breakdown of eleven products which have been available for the past year or more. All have definite advantages, and in more or less unvarying degrees, disadvantages.

• **Advantages**—The advantages are fairly obvious—size and weight being the most prominent. Another point in favor of flat conductors is high surface-to-volume ratio, causing greater dissipation of I^2R losses more rapidly than conventional cables, and resulting in less copper weight for the same current-carrying capacity. Temperature characteristics are generally excellent with some products having a range from −195 to +250 degrees centigrade. Dielectric strength ranges from 250 v/mil to as high as 2,500 v/mil.

Silk screen etching was used for most of the products surveyed, but several products were imbedded and one product (manufactured by the American Printed Circuits Co.) used a "printate" process. This is a transfer process in which the desired connectors are placed on a master carrier and, by a fusing of the uncured laminate, the circuit is embedded in a dovetail fashion. The conductor is then encapsulated by laminating another layer of teflon on the surface.

The process has several advantages such as: no etchant contamination the circuit is flush with the base, the process does not require the etching off of excess copper, and the conductor does not separate from the base when damp.

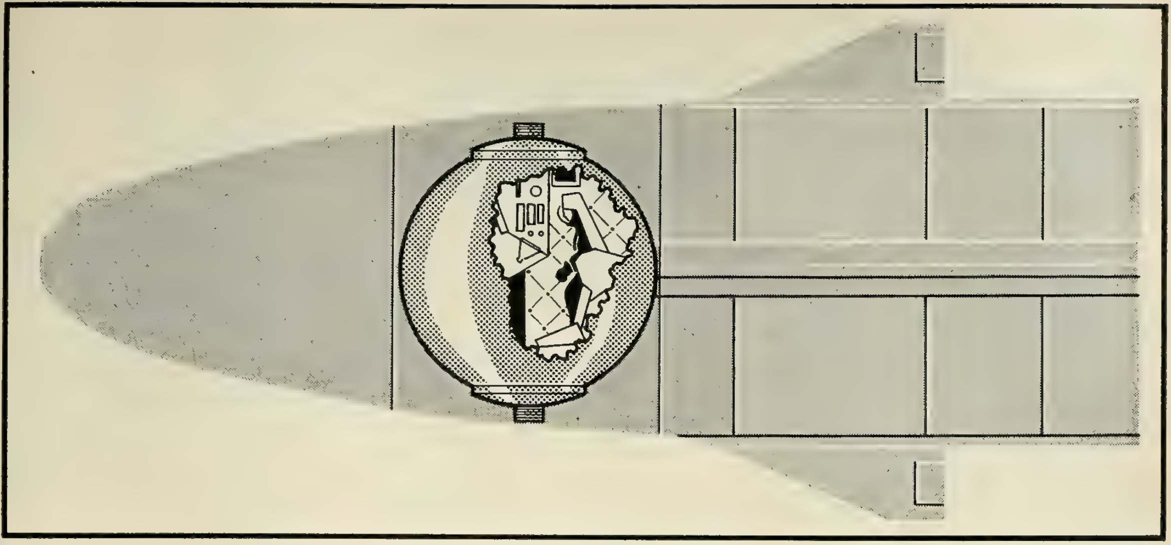
• **Disadvantages**—Some of the principal disadvantages of the products surveyed were: the base material in some of the available will crack upon sharp bending; each cable has to be designed beforehand for the specific length of run and configuration of branches and tap-offs; and, where silver is used, the silver has a tendency to migrate and short under certain conditions.

However, all of the manufacturers have been working on the problem of bending and it appears that this will not be a drawback in future applications. One of the products surveyed, manufactured by Rowe Engravers Inc., had no length or width limitations and had a base material so flexible that it did not crack even though rolled and then bent 180 degrees.

Several manufacturers, including the Tape Cable Corp. and Sanders Associates, include provision for tap-offs and branching and most other manufacturers can be expected to follow suit.

This will eliminate one major drawback for missile application since the cost of custom-made printed cables, plus the cost of spares in stock, is prohibitive compared to conventional cable. However, the significant reduction in size and weight might very well overcome any cost disadvantage, especially when the cabling is to be used in any sort of a manned or unmanned space vehicle.

The past year has seen many more manufacturers enter the printed and flat cable field and new advances can be expected in a greater number in the near future. Most of the troubles which have plagued earlier manufacturers seem to be well on the way to solution and, if newer entries in the field take advantage of these, printed cables might well turn into the sole wiring product for the space age.★



Sealed "Man Capsule" may be answer as scientists consider . . .

The Human System in Space

by C. Wright Reiniger*

THERE ARE THREE foundation blocks from which man must rise into space: Space Science, Human Science, and Vehicle Science. Yet, only the last of these has brought man to the edge of space. Knowledge of both human science and space science are far short of vehicle science. Space science will benefit quickly from the advance of weapons vehicles into space. This knowledge will chart the environment that must be survived and the unknown dynamics of space.

But so little is known of man in space that there will be no certainty of survival until every human part and process is reduced to a state of predictable performance or control.

The immediate commercial advantage of the knowledge of human science is small. The great bulk of our medical science is devoted to disease medicine. Disease medicine today tells us a great deal about the physiology of man, but still very little of man as he should be.

Knowledge of the normal processes and controls of the nervous, digestive, and skeletal-musculature-vascular systems of man shall prove the final barrier and major foundation to man's emergence into the space.

- **Weapons exclude Man**—All the major aircraft developments of the last forty years have come about in the interest of meeting more advanced weapon vehicle missions. Until the successful advent of the guided or ballistic missile, man has been viewed as a functional part of these systems.

Now with the development of even better self-correcting weapons, man is no longer needed and no longer a troublesome variable to the designers of advanced weapon vehicles. Ultimately, the assurance of predetermined mission performance will go well beyond the manned systems of the past.

This very exclusion of man is both the source and solution to the space problems that confront us today. First, it is the source because the progress of man in flight has been measurably slowed. This began to happen in the first years of the shift to missiles—the ultimate weapon. Man was viewed as no longer involved. The problems of personal equipment, environment systems, and mission performance aids were aircraft problems. Man was considered phasing out with the advent of missiles.

The technology supporting manned flight was expected to be the least useful of all the technologies creating the missile age. Only a few men refuted this misconception. The resulting restriction and limitation to work only on manned aircraft missions of relatively short-flight duration has created a deep hole in today's design foundations for man in space.

The Aeromedical Laboratory, School of Aviation Medicine, Holloman Development Center; Edwards Test Center; the Flight Safety Directorate at Norton AFB; and many contractors—working with too little, usually too late—have all made outstanding contributions to maintain a usable degree of proficiency and assurance of survival for man in space.

While the rocket has held the promise of space flight for twenty years, there is still no properly funded or properly organized advance development program underway to anticipate future manned aircraft or space man mission requirements. There are two major reasons for this void in man mission science and technology.

First, the airframe and missile contractors have not been capable of extensive aeromedical research and development. The small groups of human engineers that many of these companies have acquired in the last few years are a token effort to solve the problems of supersonic flight. Second, is the still persisting view that man is a necessary resolver of machine deficiencies.

Not only are the airframe and missile contractors not capable of extensive aeromedical research and develop-

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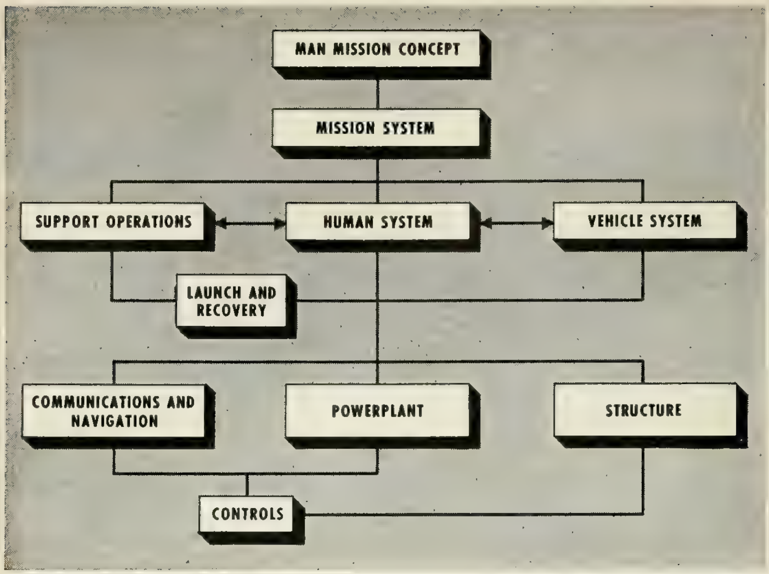
Executive vice president, Space-Flight, Incorporated.



THE MAN-MISSION CONCEPT applied to the conventional weapons systems approach can best be described in the graph as above.

ment, but they rarely engage in research and development themselves. Many expect research and development to be absorbed on specualtion by components and equipment suppliers.

In addition, the aerodynamic and structure-oriented prime contractors generally allot crew and crew equipment a lower priority on space and weight. Crew function and survival have been habitually compromised; while solutions to powerplant, structure, and armament requirements have been made more important.

• **The fixed remainder: Man**—The present systems concept has created a broad framework for operational weapon development, assigning recognizable portions to industry contractors. Unfortunately, a remainder exists.

For example: Ground support first loomed into view as a mixed batch of equipments, recognized today by companies "in the business" as the fat on the hog. Before ground support, there were realizations of individuality to airframe, powerplant, armament, and lately, controls. Ground support has largely been brought into focus by the nature of operational missile systems.

Aircraft development still carries along a mixed remainder. This is usually classified as equipment—personal and otherwise. Varied Air Force laboratory groups, contractor project sections, and component suppliers have participated in responsibility for meeting these manned aircraft requirements: crew environment and clothing, nutrition, instrument display, powerplant and control command initiation, crew communication, navigation, hazard protection, and escape procedure.

The disjointed approach to satisfying these requirements has proven progressively inadequate in solving critical problems of manned flight. Notable items on the record are:

Toxic environment resulting from combustion and fluid leakage fumes; snow, rain, and fog in the cockpit resulting from inadequate and uneven environment control and system capacity; clothing obstruction to adequate ventilation and easy freedom of movement; rudimentary or non-existent solution to feeding and elimination needs; instrument displays seriously limiting pilot response and ability; the frequent physical impossibility of maintaining control command; a maze of manual navigation aids; little or no fire protection; and lastly, the dramatic episodes resulting from second-rate attention to crew escape until long after the advent of supersonic aircraft.

This touches only the surface of the development record surrounding the crew function in manned aircraft. Failure to recognize these demands on Human Science can only prove a decisive deterrent in support of man in space. A re-orientation of development responsibility must come about.

Today, there are two distinct areas of development in progress: Weapon Mission and Man Mission developments (described as the Human System). The redirection of human technology within this framework will allow responsible anticipation of human requirements and mission functions.

• **The human element**—In simplest terms, the Human System is the development and integration of all components, assemblies, equipments, and subsystems required for the Man Mission not ordinarily required for the Weapon Mission. It can be compared to the part played by a powerplant, distinguishing between powered and unpowered aircraft.

The Human System consists basically of environment, protection, observation, communication, vehicle command, and escape. Within the Man Mission concept, the Human System will affect all other systems and support operations. The purpose of all other systems of the Man Mission is to deliver the Human System—much as the purpose of the systems within the Weapon Mission concept is to deliver the Warhead System. Man should no longer be required to keep the parts working and preserve the vehicle for another day and another target.

The first ventures of man into space should simulate every major factor of his environment, including gravity. This first venture should make it possible for variations in method and degree of simulation to be experienced at the will of man. This should not be accomplished as a daring aeromedical experiment, but to confirm results of exhaustive laboratory investigation.

The investigation should develop sufficient knowledge of human process and structure, to allow prediction of human performance under possible conditions of environment, psychodynamic control, and mission function.

• **Future prospects**—The establishment of a Human Systems Development Program for space missions has been proposed over the past five years by the author with increasing success. The early interest of command officers such as Brig. Gen. Donald Flickinger encouraged continuing efforts to "sell" and organize technical support for this program.

Later, increasing technical and command level support and guidance resulted in more formal presentation and recognition of the program's merit by Lt. Gen. Donald Putt, Major Gen. Marvin C. Demler, Major Gen. Leighton Davis, Col. Jack Bolrud, Col. Norman Appold, and others responsible for development programs.

Today, the X-15, Dynasoar, and manned satellite projects serve to underscore the recognized need for establishment of a Human Systems Development Program. The successful closing of this gap in the systems concept should prove a forward step, not only to programs for Man in Space, but to all forms of manned flight and life on Earth.★

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SEPTEMBER

American Rocket Society, Fall Meeting, Hotel Statler, Detroit, Mich., Sept. 15-18.

13th Annual Instrument Automation Conference, Convention Hall, Philadelphia, Penna., Sept. 15-19.

ASQC, 5th Annual San Francisco Bay Area Conference, Stanford U., Palo Alto, Calif., Sept. 19.

Professional Group on Telemetry and Remote Control, 1958 meeting, American Hotel, Bal Harbor, Miami Beach, Fla., Sept. 22-24.

Standards Engineers Society, Seventh Annual Meeting, Franklin Hotel, Philadelphia, Pa., Sept. 22-24.

Air Force Association, Airpower Showcase, Dallas, Texas, Sept. 25-28.

ASME Power Conference, Statler Hotel, Boston, Sept. 28-Oct. 1.

OCTOBER

Third Symposium on Hypervelocity, Host: Armour Research Foundation, Sherman Hotel, Chicago, Ill., Oct. 7-9.

Armour Research Foundation and Illinois Institute of Technology, Annual Noise Abatement Symposium, Hotel Sherman, Chicago, Ill., Oct. 9-10.

Fuels-AIME Conference, American Society of Mechanical Engineers, Old Point Comfort, Va., Oct. 9-10.

ASME, Lubrication-ASLE Conference, Statler Hotel, Los Angeles, Calif., Oct. 14-16.

Association of the United States Army, 1958 annual meeting, Sheraton-Park Hotel, Washington, D.C., Oct. 20-22.

Fourth Annual Symposium on Aviation Medicine, Miramar Hotel, Santa Monica, Calif., Oct. 22-24.

SAMA Laboratory Apparatus and Optical Sections' Midyear Meeting, Westchester County Club, Rye, N.Y., Oct. 26-28.

Institute of Radio Engineers East Coast Conference, Aeronautical & Navigational Electronics, Lord Baltimore Hotel, Baltimore, Md., Oct. 27-28.

1958 National Metal Exposition and Congress, American Society for Metals, Public Auditorium, Cleveland, Ohio., Oct. 27-31.

IRE, 1958 Electronic Devices Meeting, Shoreham Hotel, Washington, D.C., Oct. 30-31.

NOVEMBER

Conference on Scientific Information, AFOSR/Directorate of Research Communication, NAS, NSF and the American Documentation Institute, Mayflower Hotel, Washington, D.C., Nov. 16-21.

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Why A Patent Attorney In Space Age?

He can spot pitfalls for manufacturers and inventors, smooth paths from mind to hardware

by Robert Levine*

WHATEVER the contemplated role of the professional man in society, he must be aware of the fact that a new world is evolving at a pace which strains his comprehension of the many shifting factors involved. Merely by reading the new publications referring to biochemistry, space medicine, magnetohydrodynamics, ULF, monopropellants, organic chemistry, neutron absorption, etc., he readily sees how intricate some of the concepts that he has been working with have become.

Not only have his own specific areas of interest become more complex, but more and more, he must be able to relate his work with accomplishments in other fields that were at one time quite unrelated. In this connection, the patent attorney's roll can be vital to any company wishing to establish or maintain a competitive lead in this changing age of rockets, missiles and space flight.

When the patent system was established, it was thought that whatever difficulties would develop would be rooted in the human frailities in trying to protect creative effort and to guard against usurpation of ideas by others. It is apparent that this concept of inventorship has been radically changed in the last few years.

The true inventor may be someone entirely unrelated to the person who filed the patent application. An inventive idea can no longer be confined: scientists travel from country to country, exchanging ideas broadly, to the extent that results spring up in a multitude of places. Who is the true inventor? By the same process on a smaller scale, who is the true inventor in the corporate "team" which is the breeding ground for the complex "system" type of many inventions?

• Inventor coming back?—But, the cycle seems to be coming around—the individual inventor is becoming "king" again—he is becoming more and more important. But, the inventor is no longer the garret dweller of storybooks. He now has the vantage point of a great university, and his inventions are made in the university laboratory. The attitude and perversities of the intellectual scientific seeker are now related to the needs of the financier, the promoter, and the administrator of corporate welfare.

Until very recently, the administrator or the director of research did not have to know too much about the vagaries of research. He thought "common-sense" would see him through. Tasks were assigned on the basis of "man-power available," with little understanding of the direction that this manpower should take. Now, all this is gone, washed away by a technological tidal wave.

The thought and attitudes prevailing in the business world are being revamped, because, whether "business" likes it or not, survival depends not on a known depreciation factor, or the new financing of old capital structure. Survival depends on time, and on the knowledge that the next day's advantage in the market place will be lost the day after by some new technological concept erasing an old product.

• New role for lawyer—In this state of affairs, the duties and functions of the patent lawyer become entirely different from his previous role in the business world. His role is now the role of the trouble-shooter, the man with knowledge of where the industry will be in the years to come. He i called in to appraise the research "problem," as it is now called, so that direction may be given to administration of research.

The reason for this is obvious. In the usual business organization, which carries on a multitude of "new product" activities, communication between individuals and departments has now broken down to the extent that the sole answer to research activities lies in the patent department. This department is the communication link and liaison between all departments of the firm; advertising, research, financial, and the outside world of industrial knowledge, as exemplified by activities of competitive firms and fields.

In addition, the problem created by engineers and technicians continually moving from job to job places an additional burden in determining where inventions really originate.

Whatever the patent attorney believes his function to be, management feels that he should always be in the position to rid the company of its troubles immediately; the engineer thinks of him as a negative influence; the comptroller believes him to be a burden upon the budget, and everybody concludes that without him, the world would be easier; except for the fact that they need him badly.

In short, the patent lawyer is looked upon as saviour or miscreant, depending upon whether he is a protector of the inventor, or an advisor to the facts concerning the coverage of claims

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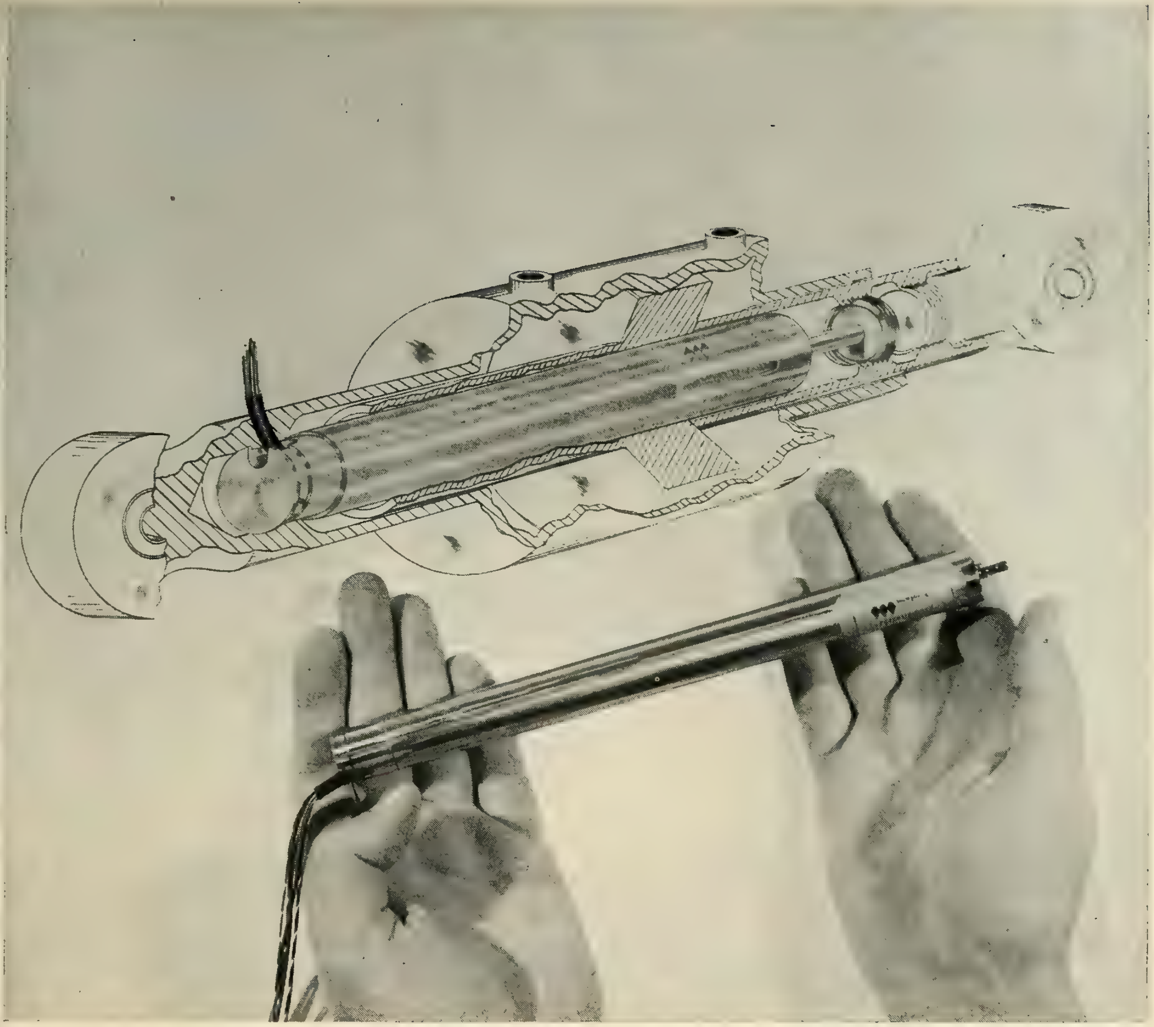
* *Patent lawyer,*
P. R. Mallory & Co., Inc.



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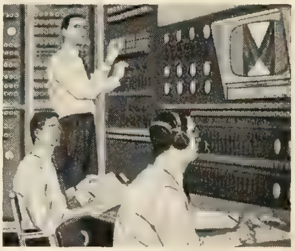

in a patent that should be avoided.

• Patent research—Some examples of where the patent attorney was instrumental in directing research into the missile and aircraft fields come to mind.

One of the most important advances in aviation instrumentation was the Lindberg Engine Analyzer, which has been instrumental in saving thousands of lives in Korea.

The engine analyzer was presented to a research group for evaluation. The results of the evaluation were noncommittal. However, the patent attorney was called in to estimate the inventive possibilities. The patent attorney immediately saw that the disclosure as it went to the evaluation group had missed several important practical inventive concepts. Knowing the art, he asked that the disclosure be forwarded to the Patent Department where a new evaluation indicated the practical significance of the device.

As a result, patents were secured for the engine analyzer. The corporation was then able to manufacture the device under license from Lindberg. The invention became one of the most important contributions to aviation in recent years, and has been given several awards for achievements.

Another instance occurs with reference to a sub-miniature snap switch. The switch manufacturer was asked to evaluate several types of precision switches. In order to determine the merits of the switch, the patent attorney was called in.

At his recommendation, the switch was given a high evaluation as to the commercial prospects. This was because on practical test, the patent attorney saw that the switch embodied a stress principle which was never properly presented to the engineers sent out to estimate its significance. This feature was in the aspect of overcoming a "dead stall" point inherent in other such snap switches. This feature was only brought out by going through a step-by-step review with the inventor and finding out that this important aspect, which was understood to him, had never been properly transmitted to the engineers.

This made the sensitivity of the switch exceedingly important in rocketry, guidance equipment and landing gears for jet planes, where instantaneous reactions were necessary in making and breaking circuits. This sub-miniature type switch has now a very valuable place in the aircraft, missile and computer arts.

A third development which was

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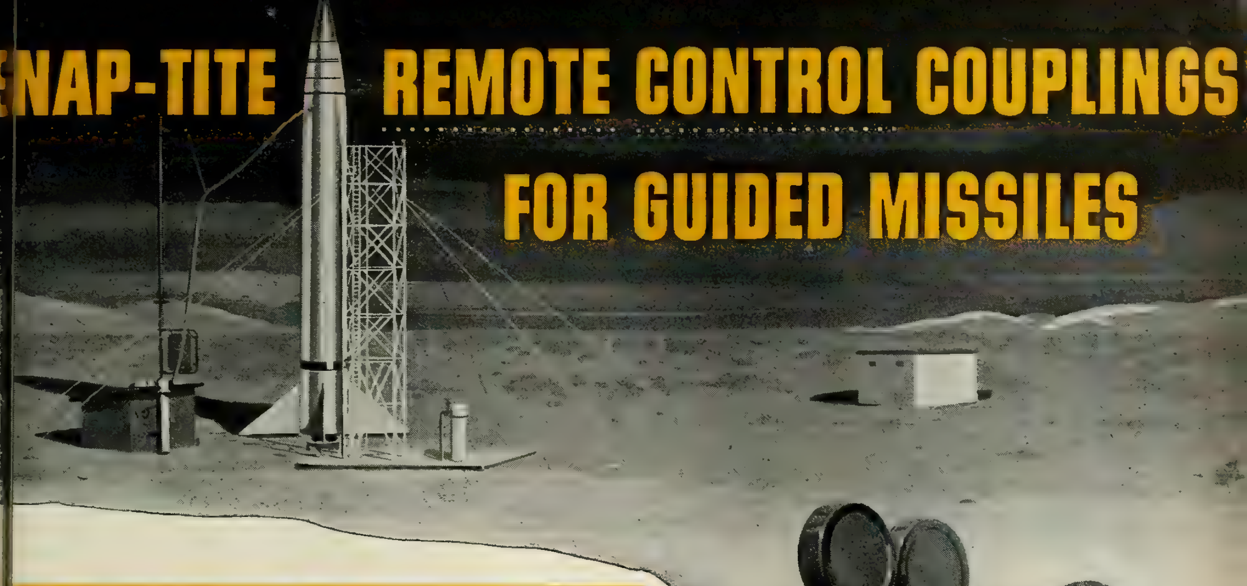
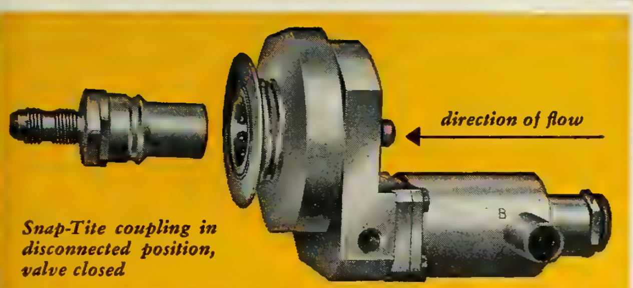
NAP-TITE REMOTE CONTROL COUPLINGS FOR GUIDED MISSILES





Snap-Tite coupling in disconnected position, valve closed

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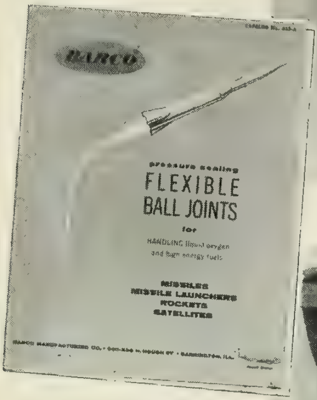

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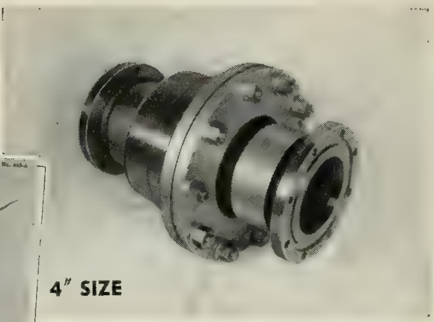

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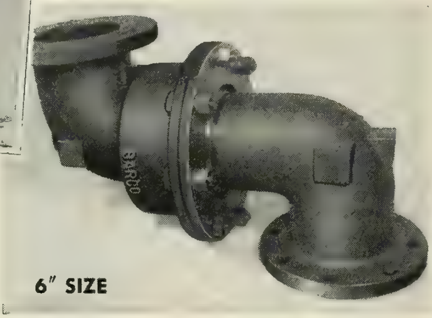

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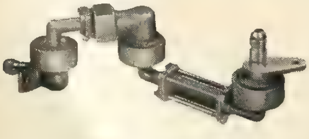

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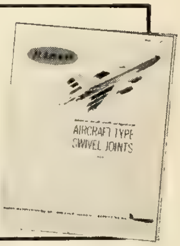

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sparked by the patent attorney was in the "titanium" alloy fields. For years, all new alloys were being subjected to hard scrutiny, and step-by-step, new characteristics had to be evaluated. Since this was a new metal, it made it necessary for the patent attorney to educate engineers and examiners in the U.S. Patent Office concerning new principles involved in alloying titanium, so as to encompass many results unavailable with other alloys.

It is now a fact that titanium today, with its strength to weight ratio, has become one of America's great standbys in the missile arsenal. Moreover, the immunity of the metal and its alloys to corrosion has made it a factor in the chemical and naval industries (submarines)—since salt water and other corrosion-type environments have made no impact on this metal.

The development of these alloys and their protection in industry could only have come about through the untiring efforts of the patent attorney in seeing that patent protection was obtained for the metal. The results of this effort have created an entirely new industry, the future of which is tremendous and marks a breakthrough in providing a requisite metal for fire walls and engine frames where corrosion, strength and heat problems were almost absolute deterrents.

• **How to do it**—The problem of the patent attorney is considerable, especially when research and patent funds are limited.

The patent attorney's experience in untangling the skeins of knotted logic; his analytical approach to the problems involved; and his awareness of the practical and financial results make for his unique position in controlling the business situation. He must be aware of the great challenge to American industry by other nations, particularly in the ideological struggle between East and West.

The importance of this aspect of technological progress in the world today should not be overlooked, especially when your opponent is waging war with terrific advantages of chattel labor, unlimited capital, irrational command of forces, rampant ambition and no need for a return on investment capital or a requirement for profits.

The patent attorney must be able to play the roles of lawyer, production man, research director and financier, as well as other functions ordinarily ascribed to him. These duties and functions have fallen to him by default.

Man-Machine Relationships: A New Field for Engineers and Scientists

A new field for Operations Research Specialists, Engineers, Computer Programmers and Behavioral Scientists has arisen from SDC's work on relationships of men and machine systems.

It involves two major projects: **1** *creating and conducting large-scale training programs in present and planned air defense systems; and* **2** *operational computer programming for SAGE.*

Attaining the most effective interaction between men and machines in these programs is of prime importance. It requires intensive effort in an unusual combination of technical and scientific areas. As such, it is a new field of endeavor.

Both programs also have these elements in common: • they are constantly changing in problems • they are long-range in nature • they are essential to the welfare of the United States.

The close interrelationship of these programs, the widely diversified specialists engaged in them, and the dominating influence of man-machine relationships make SDC's work unique. Operations Research Specialists, Engineers, Computer Programmers, Behavioral Scientists — all find their assignments reflect the unique qualities of this new field.

The growing complexity of SDC's work has created a number of positions in these fields. Inquiries are invited. Address: R. W. Frost, 2414 Colorado Avenue, Santa Monica, California, or phone collect at EXbrook 3-9411 in Santa Monica.

SDC

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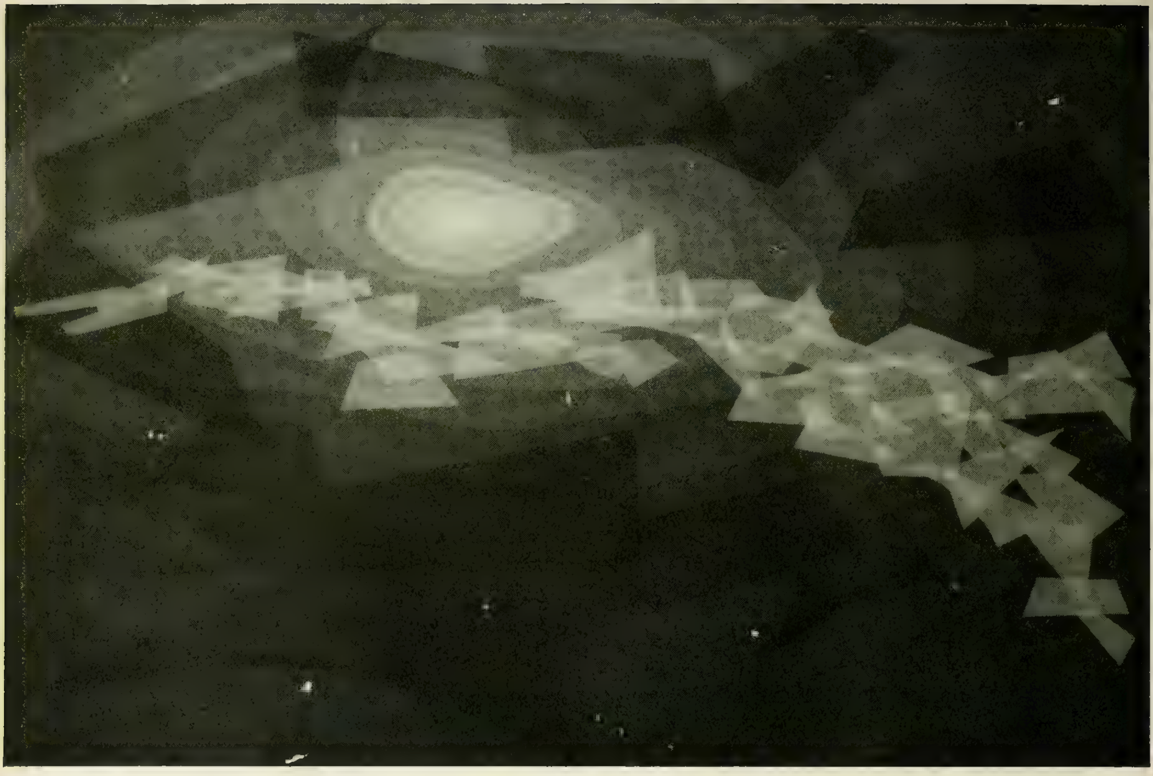

"CYGNUS," another inspiration by Simpson-Middleman, painters of the meanings of science. "Knowledge of the Universe," say these artist-scientists, "is not a matter of man's sight, but of his imagination's vision. Our eyes show us Cygnus. But creations of our genius, such as the radio-telescope, reveal unexplored, unexplained sources of energy that man may someday master. They lie amidst and even beyond those mysterious, drifting clouds of cosmic matter, lit by the stars they do not obscure." Painting courtesy John Heller Gallery, Inc.

Space-age research at Boeing

Creative scientists find at Boeing a research environment planned to help them reach and stay at the top in their special fields. Pure research along the very frontiers of knowledge is the sole concern of members of the Boeing Scientific Research Laboratories. Problems associated with man's conquest of air and space are high on the agenda, supplemented by investigations in other, equally advanced areas.

Aerodynamicists and mathematicians participate in these programs, along with nuclear physicists, physical chemists, theoretical metallurgists and physicists specializing in electronics and solid state physics. Scientists interested in imaginative, creative research are invited to communicate with Boeing.

Other Boeing openings are available to mathematicians and to engineers of all categories. Assignments are open in the fields of research, design, production and support engineering. For complete details, drop a note now to Mr. Stanley M. Little, Department R-79 Boeing Airplane Company, Seattle 24, Washington.

BOEING

. . . patent attorney

Wherever there is a "no-man's land" of function, it is usually the patent man who is assigned to the task.

In carrying out such functions, a plan must be followed. Here is a 10-step program that is workable:

(a) Gear the physical plant facilities to new developments.

(b) Be on the alert to new development going on in other sciences and industry.

(c) Watch the universities for latest reports in the field.

(d) Watch and participate in fellowships and scholarships.

(e) Tighten up liaison between departments.

(f) Continually upgrade the knowledge of the research staff by providing scholarships, adult education courses, visiting lecturers and planned industrial trips.

(g) Protect the history of the company growth, so that duplication of effort may be avoided.

(h) Create attitudes of constructive thinking: tooling costs and developments which are discarded are very costly, and in many cases could be avoided.

(i) Use library facilities and government sources as much as possible.

(j) Regularly survey output of all departments. Show an interest in what is going on.

By utilizing the patent attorney in this manner, a company provides itself with yet another weapon with which to fight, not only in the rough-and-tumble competition of commerce, but in the much more deadly battle that now engages the world.★

Northam, BJ Electronics New West Coast Merger

Northam Electronics, Inc., has been acquired by the Byron Jackson Division of the Borg Warner Corp., according to an announcement by Borg Warner and Northam's parent company, Norris Thermador Corp.

Northam's Alpadena, Calif., facilities will be merged with BJ Electronics in Santa Anna, Calif. The merged engineering and production departments will be under the direction of John R. Harkness, vice president and general manager of BJ Electronics. Eugene Bollay, formerly president of Northam, will be director of research, meteorology and instrumentation.

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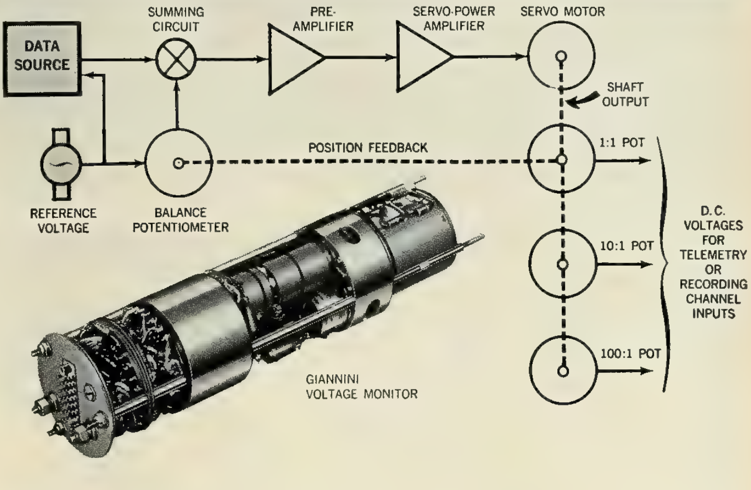

GIANNINI PRECISION VOLTAGE MONITORS are Data Repeaters which utilize the scale multiplying technique. They have an inherent accuracy of 0.035% under all conditions, and repeatability of one part in ten thousand. This is the first time that such accuracy has been possible in a small (2¼" x 9") unit capable of withstanding the extreme environments of airborne operation.

THE PRECISION VOLTAGE MONITOR alters a transducer or control system signal so that data relayed to the telemetering or recording system is less susceptible to system errors. A unit designed for incorporation in the airborne telemetering system of Chance Vought's Regulus II results in telemetered data with approximately 0.04% overall error. This figure is conservative, and includes the effects of all unit error sources such as hysteresis, linearity, temperature effects, and long term drift, as well as telemetering system error.

A VOLTAGE MONITOR CONVERTS AC output signals from an airborne data source into 3 DC voltages, representing the data to four or more significant figures. These three separate units of information are fed into the telemetering or recording system on three separate channels. The result is transmitted information with an accuracy of four or five significant figures.

WITHOUT CHANGING THE CIRCUITRY of the transmitting system in any way, errors incurred in transmittal are restricted to the fourth or higher order significant figures.

Designed to satisfy the extreme environmental demands of aircraft and missile data systems, Giannini Precision Voltage Monitors are also readily adaptable to other airborne or industrial applications requiring precise voltage monitoring, data repeating, or data multiplexing. They are available in voltage ranges from 0.0 to 0.8v to 0.0 to 100.0v, and sizes from 2¼" x 6" to 2¼" x 9".

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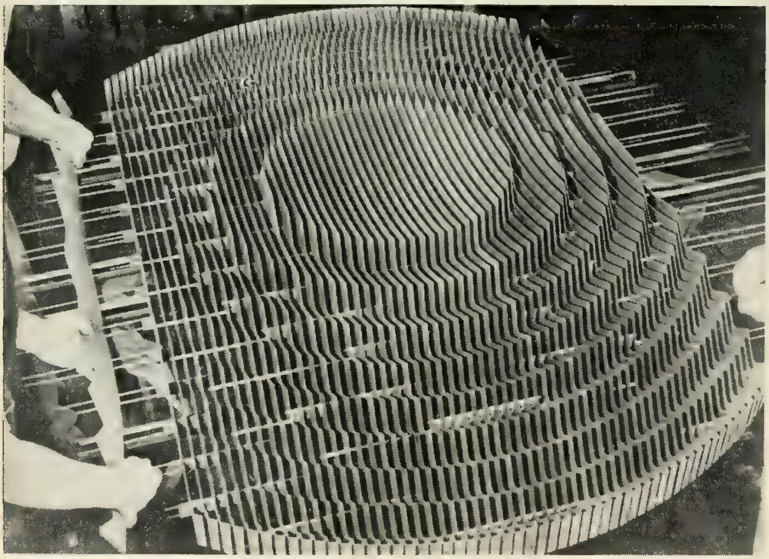
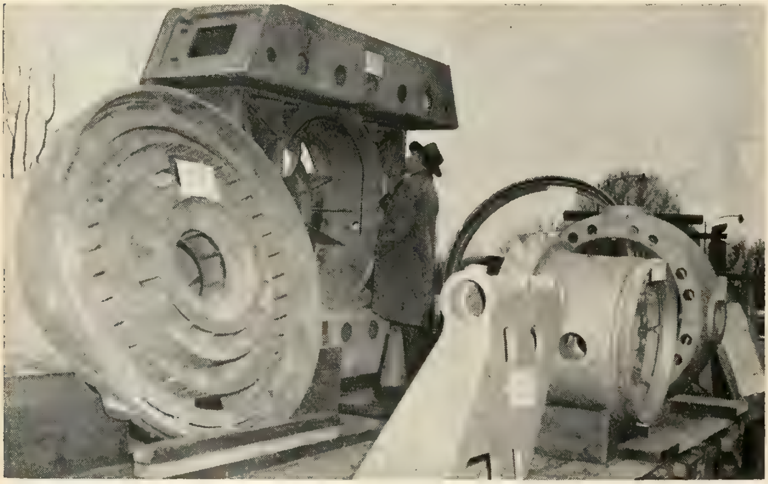
Magnesiu

by Carl N. Mortenson*

MAGNESIUM FABRICATED radar cabinet for ***Nike-Ajax*** **weighs only 280 pounds.**


70-POUND TRACKING LENS assembly is held together by plastic-coated steel wires.


BULKY PARTS of ***Nike-Ajax*** **tracking assembly look heavy, but weigh 3,200 lbs.**

USE OF MAGNESIUM alloys and products in missile systems may exceed that for piloted aircraft structures and associated equipment. Today, magnesium is being used in 20 different missiles, and is being designed into several space projects.

Here are the reasons for this growing use of magnesium in the missile industry: new alloys and products, most important of which are the elevated-temperature magnesium alloys introduced during the last five years. These have prompted many designers to consider magnesium for the first time and others to reconsider it.

There also have been significant advances in shop-processing and fabrication techniques, necessary to permit the use of these alloys in practical structures. The most recent are arc-welding techniques and elevated-temperature forming methods, resulting in improved metal-forming efficiency.

Of equal importance has been the development of improved protective finishing systems and procedures for magnesium, particularly for dissimilar-metal couples and, more specifically, for mechanical fasteners. Many of these finishing systems are already in use and are proving considerably more effective and serviceable than previous methods.

• **Missile uses**—Among the oldest and most significant users of magnesium are the *Nike-Ajax* and *Nike-Hercules* systems. The *Nike-Ajax*, including booster, has approximately 100 pounds of magnesium sand castings. It appears that *Nike-Hercules* and *Nike-Zeus* will have an equal or greater amount.

The missile structure of *Nike-Ajax*, apart from the booster, uses magnesium alloy castings in guidance structure and door; control housings for rudders, elevators, and ailerons; aft housing, and main fin fittings and channels.

The ground guidance and support equipment required for *Nike-Ajax* and *Hercules* contains 3,500 to 4,000 pounds of magnesium sand castings, extrusions, and sheet. Significant amounts of sheet and extrusions are used in the structure of the system's van-type control trailers. In addition, the M-33 tracking lens assembly mounted on top of some of the vans is practically all magnesium. This particular lens mount has four magnesium sand castings with a weight of approx-

ill It Find Biggest Market In Missiles?

imately 200 pounds. The lens, weighing 70 pounds, is fabricated from magnesium sheet held together by plastic-coated steel wires.

The van-type trailers house a number of radar console cabinets. The largest cabinet, fabricated entirely by welding magnesium sheet and extrusions, weighs 280 pounds. Some 12 to 14 different magnesium cabinets are used in the several vans of a *Nike* ground system.

Practically every part of the *Nike-Ajax* tracking lens assembly carried by a flatbed trailer is magnesium, including the large base casting, the trunion and yoke casting, the three tripod-type leg castings, the sheet lens, and extruded A-frame support trusses. Total approximate weight is 3,200 pounds.

• **Surface-to-surface missiles**—The extent to which magnesium is being used in some of the surface-to-surface cruise-type missiles can be seen by reviewing the *Matador, Snark,* and *Regulus* II airframes.

Most of the *Matador* fuselage skin is AZ31B-H24 magnesium sheet, with a weight of several hundred pounds.

AZ31B-H24 magnesium sheet is used in the *Snark's* fuselage and vertical fin. A substantial number of magnesium sand castings are used internally. Weight of magnesium in the *Snark* is in excess of 400 pounds.

There are several hundred pounds of magnesium sand castings in the *Regulus* II, including the large 150 pound air-intake casting of AZ91C alloy. The split clamshell vertical fin tip of AZ91C alloy is cast to a thickness of approximately 0.120 inch. A substantial amount of magnesium sheet is used in *Regulus* II.

• **Air-to-air missiles**—One of the earliest of the air-to-air missiles to use a substantial amount of magnesium is the *Falcon*. Virtually 90% of the GAR-1 model structure is magnesium. The body is made from 0.040-inch AZ31B-H24 magnesium sheet (which has been rolled, longitudinally welded, and then stretch-formed to size) and ZK60A-T5 magnesium extruded tube. The four stabilizer frames, each weighing about four pounds, are made from AZ91B magnesium die castings. The four rudders attached to these frames are machined from ZK60A-T5 forgings.

• **Surface-to-air missiles**—The Navy surface-to-air missiles, *Terrier* I and II, use magnesium sand castings, including wings and fins, as well as magnesium plate in fuselages. *Talos* uses an unspecified number of castings.

The most extensive use of the high-temperature magnesium sheet alloy HK31A-H24 is in the *Bomarc* surface-to-air missile. There are an estimated 200 pounds of magnesium per missile, including HK31A-H24 sheet in the fuselage, wing and tail, and HM31XA extrusions used as leading and trailing edges in the control surfaces.

The Marquardt ramjet engines which are scheduled to power later *Bomarc* models use over 200 pounds of HK31A-T6 magnesium sand castings and magnesium sheet alloy throughout the entire diffuser section.

An HK31A-T6 magnesium sand casting, weighing about 20 pounds, forms an access door and hydraulic equipment package in the *Bomarc* fuselage. Use of magnesium saved about six pounds over the previous design.

• **Ballistic missiles**—The most recent use of magnesium in the missile industry is in the ballistics missiles. Illustrating a starting point for magnesium in such weapons, is the use of both room- and elevated-temperature magnesium sheet alloys in the *Vanguard* satellite launching vehicle and the satellite sphere itself.

AZ31B sheet is used in the 20-inch diameter sphere shell and in the tail can and spacer sections. The most significant application, however, is HK31A-H24 sheet alloy as contour skin for the second stage rocket. This is an indication of applications to come in future ballistic weapons, for they will use this sheet in areas subject to the same range of temperature (about 500-550°F) as the *Vanguard* second stage.

Although security restrictions do not permit at this time a disclosure of the exact amount or areas of magnesium usage in the *Polaris, Atlas, Titan, Thor,* or *Jupiter,* it is understood that magnesium sheet and extruded and cast products will find significant applications in these missiles.

Development of still newer sheet alloys with high strength at room temperature has led, for the first time, to favorable consideration of magnesium wrought products for quantity production of large welded structures.

These newer sheet alloys, unlike earlier materials (notable AZ31B), need no thermal stress relief after welding. Combined with excellent weldability and weld-strength efficiency, this advantage will offer higher productivity in large structural assembly operations.

While exhaustive service test data proving complete compatibility of magnesium with liquid oxygen and liquid fluorine is not available, interim laboratory test data and experience indicate that magnesium will perform satisfactorily as a storage container for both. Since these oxidizers are at temperatures of approximately −300°F, mechanical properties at such temperatures, including impact and weld strength, are now being determined for those alloys believed most suitable.

Results already available at temperatures down to −300°F, indicate significant increases in ultimate and yield strengths. Although elongation decreases, there is no sharp drop or change in the slope of the elongation vs. temperature curve, and at −300°F the actual values are still adequate for use in this type structure.

• **Why increased use?**—Where missile performance requirements demand a minimum-weight structure, and where magnesium's strength-to-weight ratio or rigidity-to-weight ratio is unsurpassed, magnesium usage will increase in both the second and primary areas of the missile structure, as well as certain components of the ground-support system.

Structural designers are familiar with the various theoretical analyses used to calculate strength-to-weight comparisons. One concerns the resistance to compression buckling of a column, and is known to be proportional to the parameter Et^2, where E = Young's Elastic Modulus, and t = section thickness. Therefore, Et^2/density is of real importance in design of missile skin structures.

Comparison of HM21A-T8 magnesium sheet with another common missile metal for resistance to buckling in the temperature range through 700°F shows:

Magnesium sheet, with an 18% weight saving, which normally represents a difference of one gauge in thickness, will have superior buckling strength at elevated temperatures. Comparing the two materials at equal weight, the magnesium structure would be approximately 60% stronger than

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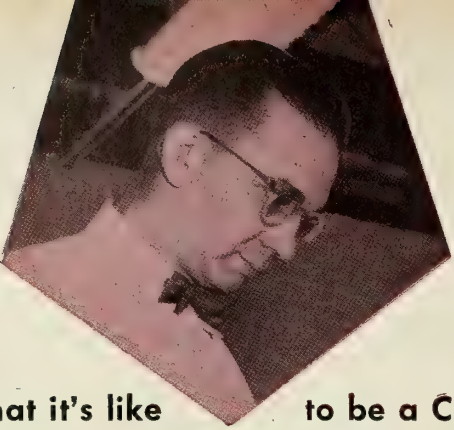
**Magnesium Technical Service and Development. The Dow Chemical Company.*



INERTIAL GUIDANCE ENGINEER John V. Prikazsky tells why airborne computer development at IBM Owego, N. Y., offers him the creative engineering career he always wanted.

What it's like to be a Creative Engineer at IBM

"Inertial guidance," explains John Prikazsky, "means aerial navigation without recourse to external reference. As an inertial guidance engineer with IBM, I have the opportunity to work on completely integrated bombing-radar-navigational systems. My work is broad — from lab studies to the analytics involved in system design—everything from shooting the North Star to heat transfer problems. That's why I like it — plus the chance I have to take on as much responsibility as I can handle."

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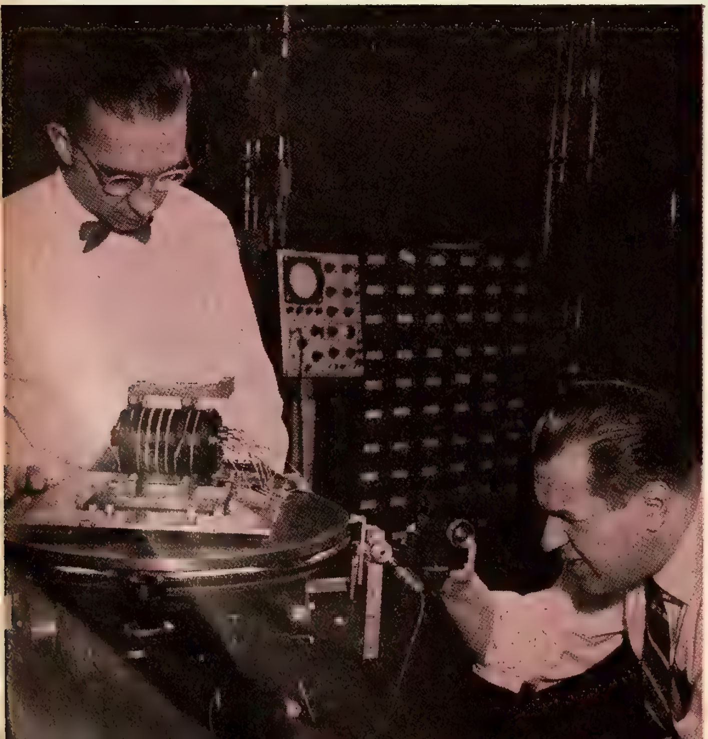


the other structure in comparison.

Structural stiffness is also a factor to be considered, particularly related to the problems of aeroelasticity and flutter. If HM21A-T8 magnesium sheet and the other metal are again compared, where stiffness is proportional to Et^3, the magnesium sheet, one gauge thicker and 18% lighter, will be stiffer throughout the elevated-temperature range. At equal weight, magnesium sheet is over twice as stiff.

The challenge created by increased missile operating temperatures has been partly met by the introduction and gradual availability of several elevated-temperature magnesium alloys.

Magnesium alloys containing rare earths were developed and came into commercial use in the early 1950s. These alloys are used for sand castings in applications where temperatures of 300°F to 450°F are anticipated. In this range, these alloys have built up a good service record.

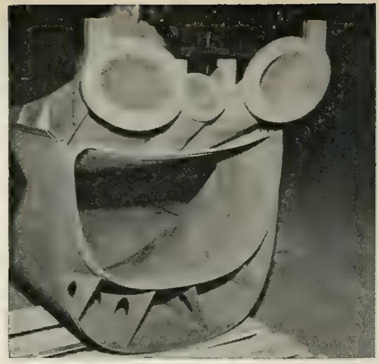
Shortly after the rare earth-containing alloys became standard compositions, the magnesium-thorium alloys were introduced—first in the form of sand castings, and later as sheet, plate, and extruded products. Already, these cast and wrought products are in use at temperatures up to 650°F. Short-time elevated-temperature property data for these products up to 1000°F are now being released.

The first magnesium-thorium sheet and plate alloy to reach full commercial status was HK31A-H24. This product was found serviceable up to 550°F for short time requirements, and up to 350°F where creep is the important factor.

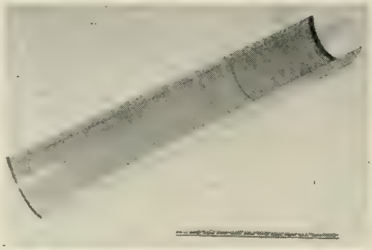
A second sheet and plate product, HMZ1A-T8, is being evaluated for long-time exposure up to 700°F, and at higher temperatures for short-time exposure. A similar composition, HM31XA-F, is being produced in extrusions for elevated-temperature use.

Although magnesium wrought and cast products do not always compete price-wise on a per-pound basis with other metals, it has been proven that a finished part designed especially for magnesium can be produced considerably cheaper than the same prototype part fabricated differently from another material.

One example of this is the growing use of one-piece, sometimes relatively-thin wall, magnesium sand castings to replace complicated fabricated assemblies consisting of many pieces in another metal. Magnesium's advantage of low density makes it possible to produce structures such as missile fins as one-piece sand castings.



THE 150 LB. AIR-INTAKE of *Regulus* II is a magnesium alloy sand casting.



ONE-HALF OF LIGHT-WEIGHT *Falcon* stabilizer is shown before welding.

NEW K1X1 ALLOY sand casting is being used for new development missiles.

• **Heat-sink capacity**—The very high specific heat of magnesium alloys results in excellent heat-sink capacity. For example, in a hypothetical transient-heating environment, magnesium, on an equal weight basis with three other missile metals, will actually have a considerably-lower skin temperature. This difference can amount to as much as a 200° to 300°F lower temperature for magnesium.

Thus, the strength efficiency of magnesium at its lower temperature may be superior to the strength efficiencies of these other metals at their higher temperatures. This can be a significant factor in the selection of materials for a ballistic-type missile or one of the anti-missile missile projects, such as *Nike-Zeus.*

A little-known advantage of magnesium over other common construction materials is its inherently-high damping capacity (the ability to absorb vibrations and not transmit them). This characteristic has been explored and is, perhaps, most useful in the form of magnesium sand casting and die castings.

One very new magnesium alloy, identified as K1X1, is being produced in experimental quantities for testing in actual airborne missile components. These structures provide mechanical support for portions of the missile electronic guidance system. In these areas, good damping capacity helps prevent electrical-mechanical malfunctions, somtimes caused by high-frequency, low-amplitude vibrations induced by the launching booster or sustainer power source.

The K1X1 magnesium alloy provides a damping capacity five to seven times that of some other commonly-used metals. Bell Telephone Laboratories have led in the development of testing procedures and uses for the K1X1 alloy.

• **Pending developments**—Many improvements are now known to be possible for galvanic corrosion protection and mechanical fasteners. Several fastener manufacturers are working with the magnesium industry and airframe companies to exploit these possibilities and produce compatible fasteners that will have built-in galvanic corrosion protection. The known use of certain compatible aluminum alloys, including special high-purity compositions, offer special promise. Electroplated steel fasteners utilizing metals other than cadmium or zinc, have shown similar results.

Electroless nickel, applied to magnesium in chemical baths, may prove adequate in special applications. This finish is being applied to some experimental magnesium electrical connectors.

Laboratory work now in progress promises to yield an extrusion alloy with a yield strength in the range of 40,000 to 45,000 psi.

The elevated-temperature alloy bread basket is still not emptied. Newer compositions are being readied for early evaluation.

Under development are alloys of lower specific gravity than the average of 1.88 for the presently available compositions.

What does the future hold? These and other new developments are being released at an increased rate, although in some cases they are limited to specific projects or programs. When missile and space engineering personnel become more familiar with these newer technological developments, it is certain that increased structural use of magnesium will result, opening up new markets for its further world-wide use.★

Soviets Certain They'll Be First On Moon

Long-standing, deeply scientific studies of space travel lend strength to beliefs of leaders and citizens

by Dr. Victor P. Petrov*

"SOMEWHERE in the Soviet Union, there is a youth today, who though he may be unaware of it, will be the first man to land on Mars," so states academician Leonid I. Sedov of the USSR Academy of Sciences. There is not the slightest doubt in the minds of Soviet scientists, government officials, or citizens that the first person to set foot on Mars, the Moon, or any other planet, will be a Russian.

Since their spectacular success with the *Sputniks,* Soviet plans for space travel have been given a shot in the arm. The Soviets didn't need much encouragement however, because they have been planning for the space age for some time; while the U.S. jumped on the bandwagon only after the launching of *Sputnik* I.

• Space-travel minded—What have the Russians been doing in this field? A survey of Soviet scientific literature, as well as magazines, newspapers and science-fiction books, indicates that they have been seriously engrossed in the study of space travel for many years, and will continue to pursue the study of space in the future.

Soviet articles and statements on space travel have been written and publicized, not by amateur science-fiction writers, but by learned people of great scientific stature, including many academicians—the cream of Soviet scientists.

We know, that since 1951, the Soviets have seriously probed into the upper atmosphere with the aid of various scientific tools, mainly rockets. Long before the first *Sputnik* went into orbit, the Soviets sent dogs up to altitudes of 125 miles to test the animals' ability to survive in a rocket or satellite.

What preliminary work and experiments did the Soviets perform before sending *Sputniks* aloft, and what are their plans for space travel? Judging by material obtained from their publications, they are dead serious about their plans, and do not space time or money plotting a future path into the universe.

It would be timely to cite the words of a Moscow correspondent for the *New Statesman,* a British week-end review, who said: "Soviet plans for conquering space have been pretty well disclosed in the press. In this land, even 'science fiction' is purposeful and the author's fantasy is rarely permitted to range far beyond the limits of some foreseeable five-year planning period."

• Manned flights—The success of *Sputnik* I permitted the Soviets to declare that it was the first step toward conquering space. However, before sending a manned vehicle into space, they said it would be necessary to study the effect of space travel on animals, just as it was done with rockets. "We will have a *Sputnik* with animals aboard, which will permit us to make a detailed study of their reflexes and behavior, as well as observe their physiological processes," IZVESTIA declared.

This was accomplished when *Sputnik* II, weighing over half-a-ton, was placed in orbit on November 3, 1957. The originally-given weight of *Sputnik* II, incidentally, should be revised considerably upward. There are indications that this *Sputnik* weighed much more than the officially-released figure of a half-a-ton.

PRAVDA said on April 27, 1958, that the weight of *Sputnik* I was 83.6 kilograms (185 lbs.). At the same time, referring to *Sputnik* II, the article said that its scientific and measuring instruments weighed 508.3 kilograms (1,120 lbs.). Nothing was said of the total weight of the satellite.

Again, in its official report to the Special Committee of the IGY in Belgium, the Soviet IGY committee said of *Sputnik* II, "the total weight of the equipment, the test animal and the electric batteries in the second satellite is 508.3 kg . . ." This referred to the weight of the instruments and animal only. In the same report, it was stated that *Sputnik* II was ". . . carrying a *payload* of 508.3 kg, which is six times heavier than the *overall* weight of the first satellite."

[*Ed. Note: Previous questions on this same problem prompted m/r to call the Soviet Embassy in Washington for clarification. The Press Attache assured m/r that the total overall weight of the second satellite was 508.3 kg.*]

Undoubtedly, the launching of *Sputnik* III gave an additional boost to plans for eventual manned flights into space, if only by demonstration of man's ability to send aloft a vehicle weighing one-and-one-half tons. The size of this satellite allows room for a human passenger and a multitude of scientific instruments.

Immediately, Soviet scientists began talking about space flights to the Moon, Mars, Venus, and even further into the universe. Academician Sedov said that the time is not far off when the Soviets would switch from satellites to interplanetary space ships. He expressed the opinion that it will be possible to fly to Mars within the next twenty years.

PRAVDA, discussing *Sputnik* III in a two-page spread, said that the great size of this *Sputnik* and its equipment brings the Soviets to the threshold of space ship construction. A woman scientist, writing in the magazine SOVIET WOMAN, said Soviet scientists had already solved the re-entry problem and will be able to bring passengers back to earth alive. She also indicated that ". . . the problem of survival under conditions of interplanetary flight *seems* to have been solved."

• Interplanetary flights—Successful launchings of satellites in precalculated orbits around the world gave impetus to Soviet plans for constructing larger satellites; sending rockets to the Moon; rockets around Mars and Venus; and finally, manned space ships, for these trips. It is amazing that Soviet scientists were talking about these plans to come in the very near future, even before the *Sputniks* became a reality.

There is no question, said a Soviet

**Professor, U.S. Naval Post-graduate System.*

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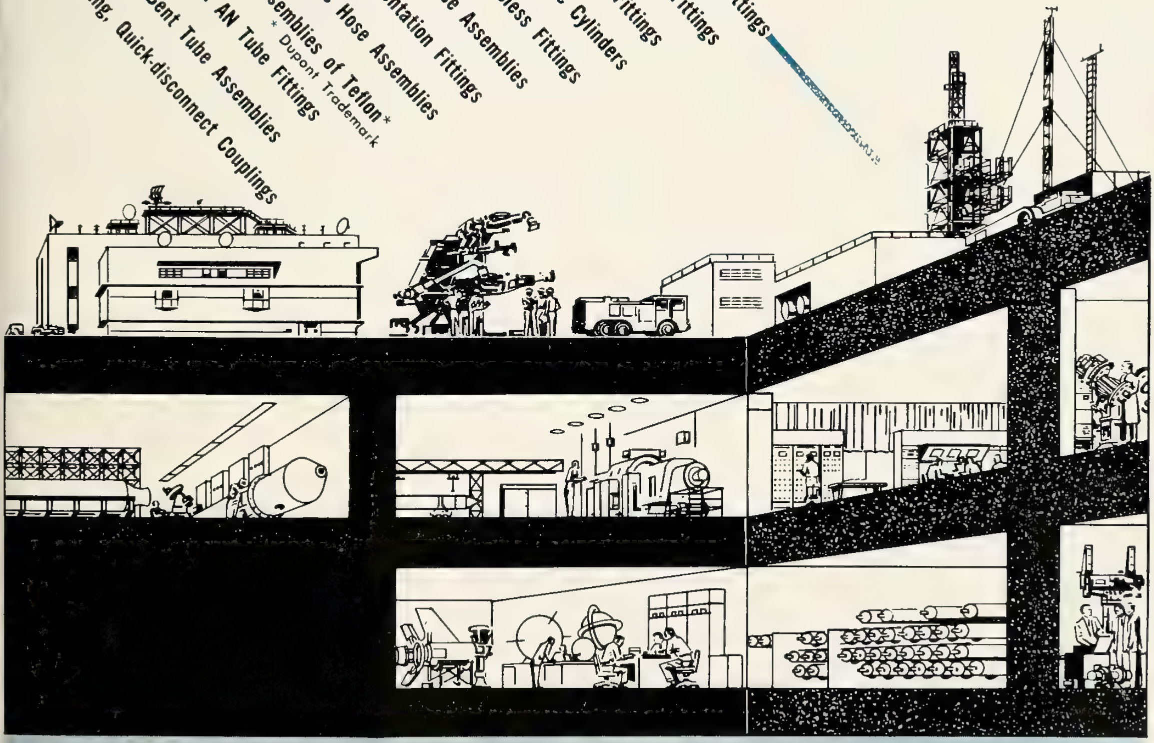

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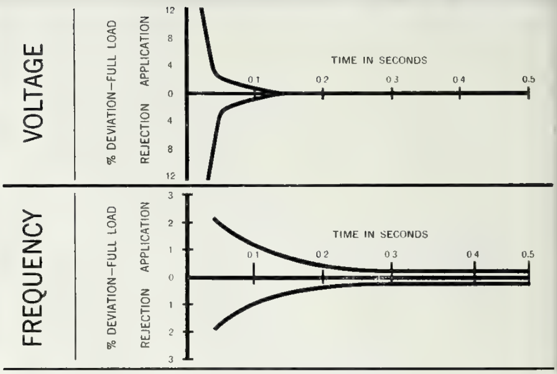
Snark Missile is powered by this Caterpillar Electric Set, photographed at Cape Canaveral, Florida. Full designation: Caterpillar 60 KW 400-cycle 120-208 Voltage Low Silhouette Portable Ground Support Unit with Precision Control Regulation.



Almost instantaneous return to normal of the new low silhouette Cat power unit (left) under conditions of full-load application and rejection is shown in the above graphs. In each case test was made under a voltage output of 117.4 volts.

Caterpillar Engines help power

Rocket boosters blazing a flaming trail, the Northrop Snark SM-62, first U. S. intercontinental guided missile, roars skyward from Cape Canaveral, levels out and hurtles south to the Caribbean.

The precise power used for ground support of the Snark is provided by a Cat Electric Set, designed and engineered for the missile program.

On isolated, down-range islands, the missile is picked up on radar, monitored as it streaks by, and the in-flight data is recorded and transmitted to Cape Canaveral for processing.

The power for these tracking stations—for the delicate, complex equipment and for living facilities for station personnel—is provided by Caterpillar Stationary Electric Sets.

Modern, heavy-duty diesel engines by Caterpillar are playing an important role in the rocket and missile program, and in other important military applications.

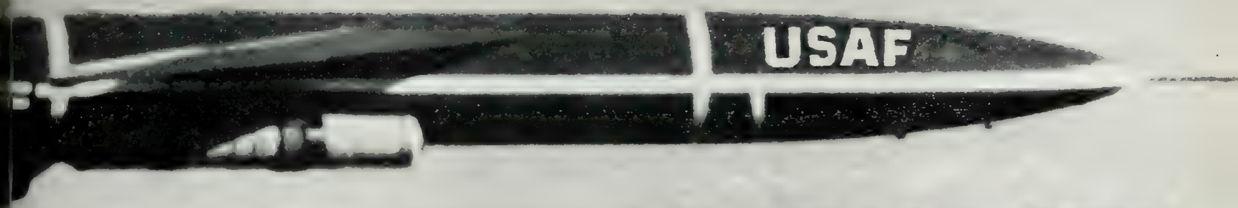
Caterpillar Engines can operate in any climate or altitude. Cat Engines were chosen to supply power for the Antarctic Expedition for the Geophysical Year (Operation Deep Freeze).

Caterpillar Engines can operate on any fuel, from JP-4 through No. 2 furnace oil, without adjustment or dilution. This means Cat Engines can use readily available fuels, eliminating storage or safety problems.

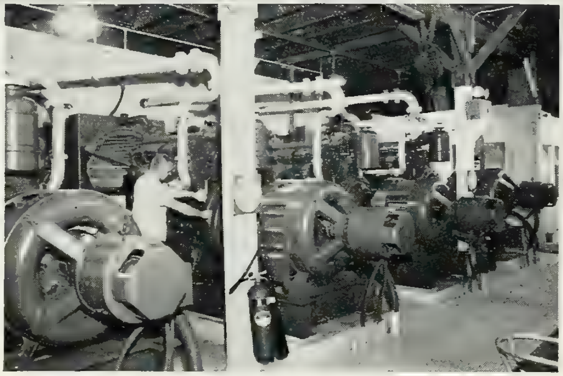
Relatively untrained personnel can operate and maintain these dependable power packages. Only

An electric organ helps relieve the monotony of life on these vital but lonely stations. Caterpillar Engines supply the electric power needed to operate effectively in remote places.

Weather information needed for missile testing is gathered in this weather station on Eleuthera. Precision equipment used here demands steady, constant diesel-produced electricity.



Central Control at Grand Bahamas Auxiliary Air Force Base is powered by Cat Electric Sets. This is one of 12 such stations that chain southeastward from the Florida Coast to Ascension Island, south of the Equator between Brazil and Africa.



These are Caterpillar Engines supplying electric power on Eleuthera Auxiliary Air Force Base, one of the down-range tracking stations. Each of the engines, generating as much as 68,000 KWH each month, has been operated more than 90,000 hrs.

United States missile program

two minor adjustments are necessary on a Cat Engine: fan belts and valve clearance.

An important factor in military preference for engines by Caterpillar is the world-wide availability of Caterpillar parts and service—832 facilities in the Free World; 398 of them within the Continental United States.

Modern, heavy-duty Caterpillar Engines are a result of more than a quarter century of diesel leadership. Creative engineering plus a quality of workmanship that is the standard of the industry has made Caterpillar power an overwhelming choice where precise, dependable diesel engines are a must.

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BY CATERPILLAR

N. W. Ayer & Son, Inc.

"We've had little down time with our dependable Cat Engines," says Burt Niro, Pan American Airways Base maintenance supervisor, Eleuthera. James McCullough, base manager, is at right.

Special Governmental Projects, Dept. MI9, Engine Division
CATERPILLAR TRACTOR CO., Peoria, Ill.

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The *New* A-MP "24-20" Terminal and Connectors are designed expressly to resist *vibration, shock and similar stresses* encountered in wire applications in every industry. They retain all of the excellent features of the A-MP Pre-Insulated Diamond Grip line, with special emphasis on the need for weight and space savings so important in today's equipment design.

Features of the *New* A-MP "24-20" Terminal and Connector are:

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- Miniaturized for space and weight savings.
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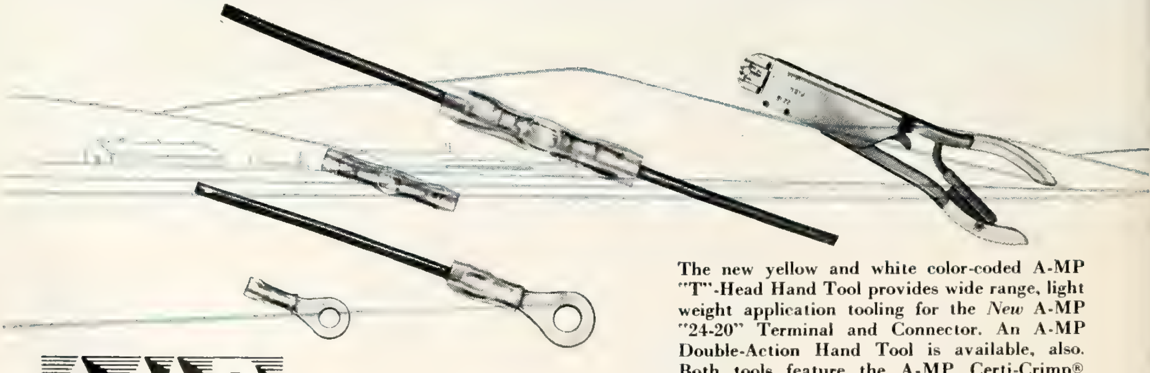

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. . . Soviets certain

aviation magazine, that "we can talk about flights to the Moon today, as an event of the near future." This statement was made in October, 1957, before *Sputnik* I was launched. The magazine even goes so far as to describe plans for building interplanetary ships of 1,700 tons each, using earth satellites as workshops. These spaceships will fly to Mars, using the sun's gravitational pull, thus conserving fuel.

The flight to Mars is expected to take 256 days. There will be a waiting period of 440 Earth days on Mars before the space travelers will be able to start their flight back. The entire trip is calculated to take 952 days.

Quite a detailed study of Venus has been planned by Soviet scientist Yu. S. Khlebtsevich, who foresees that a three-stage rocket could be sent into outer space. The third stage of the rocket would orbit around the Earth at a distance of 22,000 miles.

At that distance, the rocket will receive additional supplies of fuel by ferry rockets from Earth. After that, the rocket would blast off on a signal from Earth and travel to Venus. This flight is calculated to take 146 days.

Twenty-four hours before landing on Venus (it will be at a distance of 185,000 miles from the planet), the rocket's special electronic-telescopic instruments, with a thousand-fold magnification, would begin televising the approaching "face" of Venus. These shots of the planet (there will be at least 8,000 snapshots in 24 hours) would be transmitted to Earth.

The last view of Venus, before the rocket hit the planet's surface, would appear as if it were taken at an altitude of one hundred meters. Thus, if there were any living beings on Venus, they would be seen with the aid of the rocket's cameras. This flight, according to Khlebtsevich, can be realized sometime between 1962 and 1967.

Another Soviet scientist declared that man is now standing at the dividing line between two eras—the era of man limited by the Earth's environment, and the era of space travel, which is just beginning. The next step, after a series of *Sputniks,* will be a cosmic rocket, which will fly around the Moon.

More and more Soviet scientists are talking about rockets to be sent into space, to the Moon or Mars. It is not future generations, but the present generation, they say, who will witness the first flights to outer space. "Shortly, we will study the Moon or Mars not with the aid of telescopes, but directly . . . perhaps soon a Soviet 'lunaphysical' station will appear on the Moon." It is noteworthy that this was said, not by

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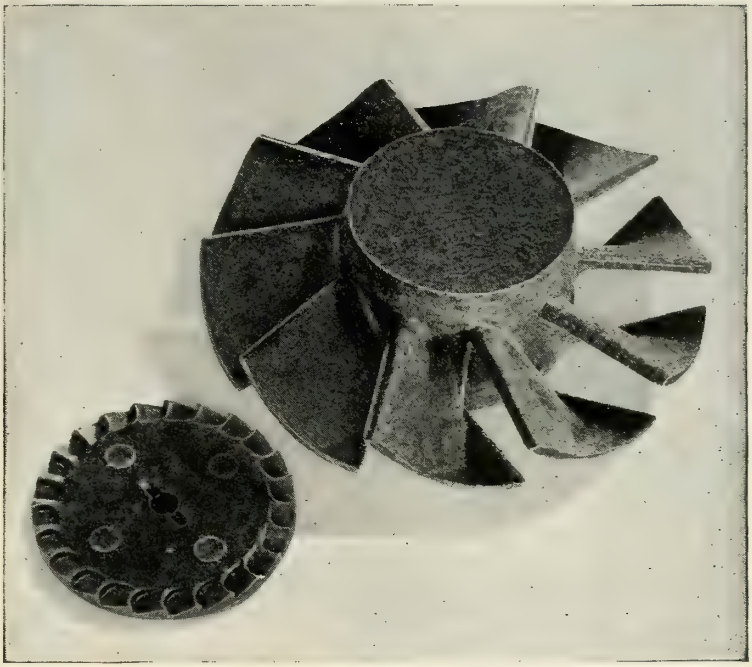

High-speed turbine wheels must stand direct rocket blast

When you are designing to meet the fantastic requirements of modern missiles and rockets with their tremendous forces and astounding temperatures, your problems are difficult ones. But you have an excellent solution: R/M Pyrotex—a complete line of asbestos-base reinforced plastic materials.

The Pyrotex products shown here demonstrate what these important new R/M materials can do for you. They provide exceptionally high strength-to-weight ratios, take a smooth finish, and can be mass produced to precision standards. Other missile parts for which R/M Pyrotex has been selected: rocket exhaust throats, nose and exhaust cones, blast tubes, grain seats, fins and combustion chamber liners. It will pay you to get more details on R/M Pyrotex.

THE COMPLETE LINE OF R/M REINFORCED PLASTICS

If your design demands all of the following features, find out more about R/M Pyrotex (felts, mats, papers and molding compounds):

- Heat and flame resistance up to 10,000°F or more
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- Little or no surface crazing
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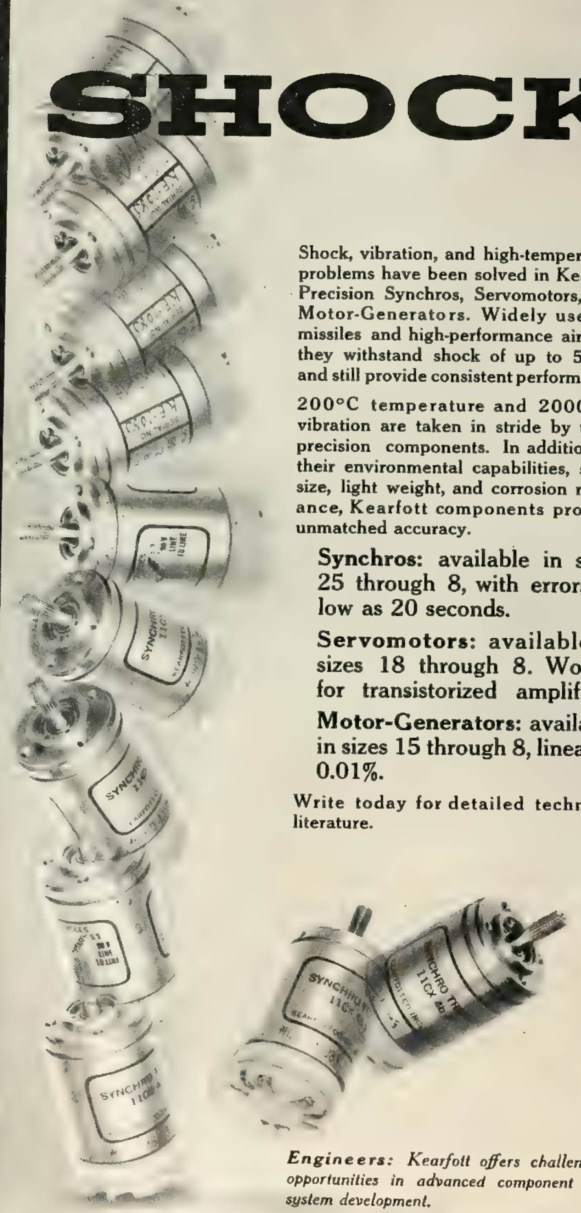

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. . . Soviets certain

some excitable dreamer, but by the President of the University of Leningrad!

• **Practicalities of flight**—These general statements bring us to the question: "How do the Soviets actually foresee the practical realization of space flight?" One publication proposes that space travel be divided into stages, and that artificial satellites of the Earth be used as a platform for changing rockets. The Moon will undoubtedly be the first objective in a series of space trips. A trip to Mars, like a trip to the Moon with a surface landing, will probably be preceded by reconnaissance flights around the planet.

The publication goes on to say that thermochemical fuel rockets will probably be the first to venture into space, and that they will be followed by atomic space ships which will be far superior. On returning to Earth, there is the problem of descent without disintegrating like a fiery meteor. The space ships apparently will be unsuitable for landing on Earth. Once in the atmosphere, the space ship will become white hot. Therefore, the publication states, the crew will descend in a streamlined glider. The abandoned space ship will either burn in the atmosphere, or be put into orbit as an artificial satellite.

Academician Sedov expresses the opinion that *Sputniks* will give such a wealth of scientific data, that it will be possible to launch a manned *Sputnik* in the not-too-distant future. However, he says, it will be easier to send an unmanned rocket to the Moon, or send it around the Moon and back to Earth, than it will be to embark on manned flights. He added that the fast progress of astronautics permits the Soviets to state that the present generation will witness manned interplanetary flights of space ships.

While discussing the future possibilities of space flights, another Soviet scientist said that to conduct scientific studies in space, it will be necessary to create manned stations on the satellites. Specially-constructed rockets may deliver members of the crew, cargo, and fuel to the stations as necessary. He also stated that even now, it is technically possible to reach the Moon with the aid of a rocket launched from the Earth.

Writing on the subject of flights into space, another Soviet scientist said that the Moon should be the first step. He added that soon after the investigations by unmanned lunar probes, man will land on the Moon's surface and build temporary shelters and scientific sta-

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REFRASIL IS IN LARGE SCALE PRODUCTION, IN A VARIETY OF PHYSICAL FORMS, TO MEET THE DEMANDS OF THE MISSILE INDUSTRY.

ASTROLITE resists up to 15,000° F for short duration uses!

If you are a Missile or Spacecraft Designer or Manufacturer—with a need for **ultra-high-temperature materials**, you know the vital importance of **low ABLATION rate.**

ASTROLITE is a remarkable **Refrasil**-reinforced plastic with impressive resistance to Ablation **and** extremely high temperatures—**up to 15,000°F.** for short-duration applications!

Fabrication techniques for ASTROLITE have been perfected to give optimum fiber orientation to resist Ablation—while retaining maximum insulation properties.

Many major airframe and missile manufacturers are using ASTROLITE today in their Space Technology programs.

Perhaps you can use ASTROLITE for insulation of Rocket Nozzles, Nose Cones, Deflector Vanes, Blast Tubes or Combustion Chamber Liners. Engineering counsel is yours for the asking. Please write to Director of Research.

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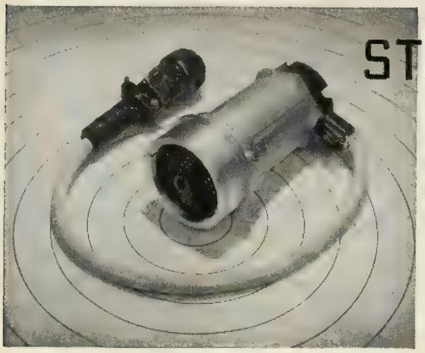

STARTING?

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This tiny guillotine severs electrical or hydraulic lines explosively by electrical command signal, can be equipped with wide range of squib provisions —two examples are shown. Many specialized types with cutting diameters to 4 in. have been produced. What can we do for *you*?

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Acceleration-integration mechanisms in this Beckman & Whitley arming and firing device are in duplicate for ultimate reliability. Total arming time adjustable from 2 to 8 sec. Has automatic reset, electrical primer safety switching and return telemetering circuitry, is adjustable for acceleration in either direction. Other types include lanyard and electrical arm/disarm canister and primacord destructors. If *your* problem is different, let us hear from you.

Pre-packaged explosive power units provide higher reliability and greater power for a given weight and volume of space than any other actuation method. Some of the many other applications to valving, ejecting, fracturing, etc., may be interesting to you. Just ask us.

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tions supplied with air and food from Earth. Later, permanent observatories and institutions will be established there; and still later, industrial enterprises to extract natural resources.

There is no doubt that flights to planets present many more problems than a flight to the Moon. Great distances and the time element necessary to reach these planets seem to be the prime difficulty. Perhaps the answer to the problem of time element is in using photon rockets in space travel, says I. I. Drakin of the Moscow Aviation Institute.

According to Drakin, the use of the pressure force of photons in the motors of space ships would be the answer to the problem of shortening the time needed for flights. He believes that the great speed of such ships, using photon beams, will make it possible to reach Mars in a mere four or five days.

• **Inspiration of space**—NOVOYE VREMIA magazine, soon after the launching of *Sputnik* III, went into poetic ecstacy, saying: "Dreams are the brightest flowers of the human mind. It rushes forward . . . it pulls Man outside to look at the Earth from above, to travel along the Milky Way, to penetrate into the farthest corners of the Universe. *Sputnik* III gave wings to these dreams . . ."

Many books have been published in the Soviet Union on the subject of forthcoming space flights. They inspire the imagination of Soviet youth, and arouse interest in astronautics. Space travel is not far off, and the West should be prepared to meet this new surge of interest, so as not to find themselves back-seat passengers in a future Soviet space ship.★

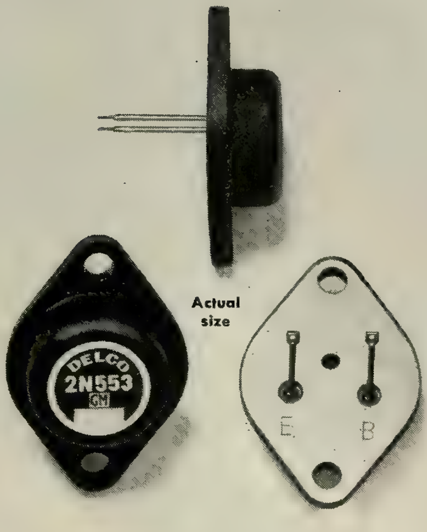
NAA Missile Division Forms Space Laboratories

North American Aviation's Missile Division has formed an Aero-Space Laboratories at Downey, Calif., as an expansion in basic research activities.

The Division's chief scientist, Dr. E. R. van Driest, will head the new department.

Plans include expansion of facilities for experimental observation of physical pheonomena, establishment of a satellite information center, and research in space navigation, communication, medicine, space dynamics, and propulsion.

Assisting Dr. van Driest in organizing the laboratories are Harold Bell, formerly chief of technical sciences, and Manuel Sanz, formerly chief laboratory scientist.



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the newest addition to the Delco family of PNP germanium transistors! It's ideally suited for high-speed switching circuits and should find wide use in regulated power supplies, square wave oscillators, servo amplifiers, and core-driver circuits of high-speed computers. It's the 2N553!

NEW HIGH-FREQUENCY POWER TRANSISTOR BY DELCO

No other transistor offers so desirable a combination of characteristics for applications requiring reliability and consistency of parameters.

TYPICAL CHARACTERISTICS T = 25°C unless otherwise specified

Collector diode voltage V_{CB} ($V_{EB} = -1.5$ volts)	80 volts maximum
Emitter diode voltage V_{EB} ($V_{CB} = -1.5$ volts)	40 volts maximum
Collector current	4 amps. maximum
Base Current	1 amp. maximum
Maximum junction temperature	95°C
Minimum junction temperature	−65°C
Collector diode current I_{CO} ($V_{CB} = 2$ volts)	12 μa
Collector diode current I_{CO} ($V_{CB} = -60$ volts)	0.5 ma
Collector diode current I_{CO} ($V_{CB} = -30$ volts, 75°C)	0.5 ma
Current gain ($V_{CE} = -2$ volts, $I_C = 0.5$ amp.)	55
Current gain ($V_{CE} = 2$ volts, $I_C = 2$ amps.)	25
Saturation voltage V_{EC} ($I_B = 220$ ma, $I_C = 3$ amps.)	0.3
Common emitter current amplification cutoff frequency ($I_C = 2$ amps. $V_{EC} = 12$ volts)	25 kc
Thermal resistance (junction to mounting base)	1° C/watt

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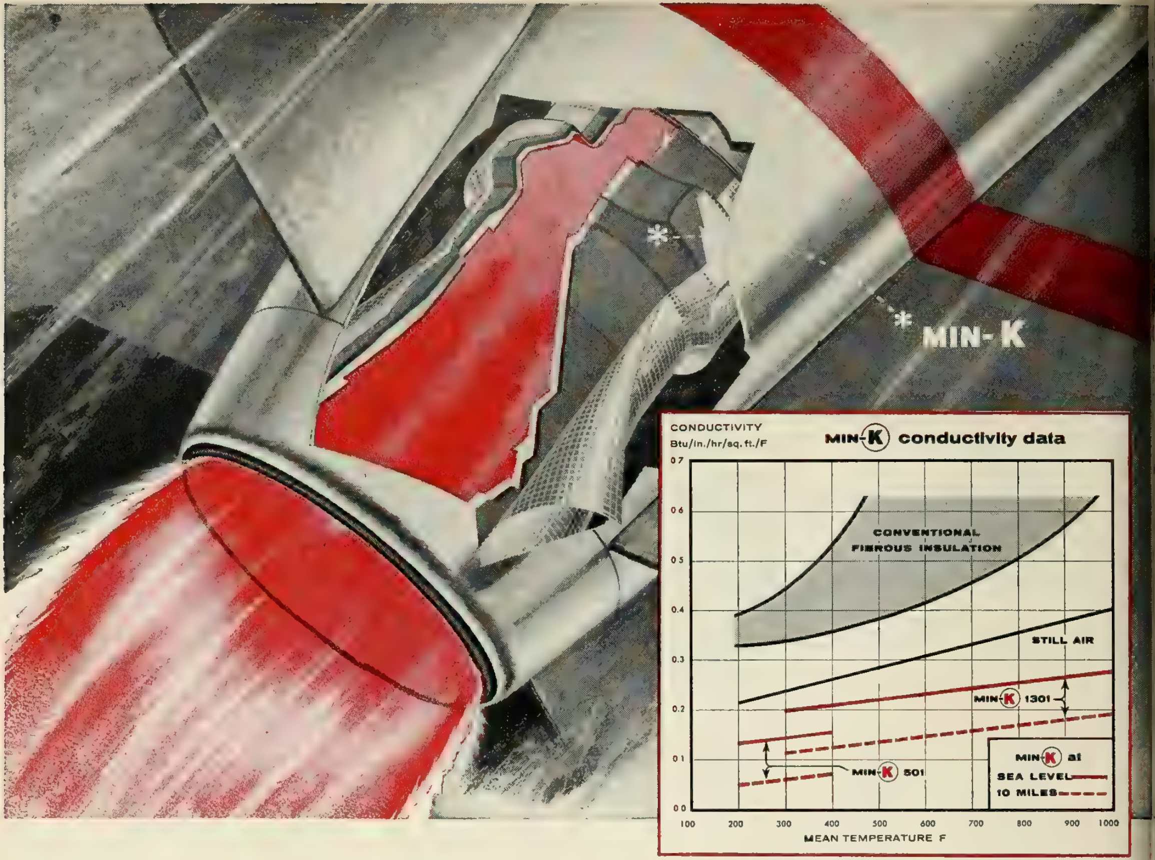

Chart compares Min-K's thermal conductivity with conventional fibrous insulations and still air. Note that Min-K's conductivity decreases with altitude.

Johns-Manville announces . . .

A scientific break-through in missile insulation!

New MIN-K has lower conductivity than still air—performs better the higher it flies

- **Saves missile space to boost fuel capacity and range**
- **Protects instrumentation more effectively to increase accuracy**
- **Offers lower thermal conductivity than any known insulating material**
- **Now performing successfully in operational U.S. missiles**

Min-K is in every meaning of the term—a scientific break-through!

For in Min-K, Johns-Manville research scientists have developed an insulating material entirely new in concept, an insulation so effective that its thermal conductivity is actually below what was long called the ultimate—the molecular conductivity of still air.

Increases accuracy and range

With this new low in thermal conductivity (less than half that of the best fibrous insulations), Min-K contributes to greater accuracy by providing more effective protection of temperature-sensitive instrumentation . . . increases range by conserving space for greater fuel storage.

Insulates better the higher it flies

Unique with Min-K is improved performance at altitude, for its thermal conductivity drops appreciably as atmospheric pressure decreases. At an altitude of 10 miles, for example, Min-K's thermal conductivity is decreased by as much as 40%, and further decreases at higher altitudes!

Manufactured by J-M as integral parts—Min-K insulations are precision molded to any shape you specify . . . encased in high-temperature metal foils or laminated to reinforced plastics. Min-K insulations include a wide variety of strengths, densities and temperature resistances.

For detailed information about Min-K, write Johns-Manville, Box 14, New York 16, N. Y. (Ask, too, for aviation insulation brochure IN-185A.) In Canada, Port Credit, Ontario.

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west coast industry

by Fred S. Hunter

Northrop Aircraft, never reluctant to try out promising new ideas, recently engaged in an interesting industrial relations experiment, which may catch on with other companies facing the problem of communicating with large numbers of workers. The company bought open time on a local Los Angeles television station for its president, Whitley C. Collins, to make a personal report on the company to employees.

The time selected was 8 o'clock, Saturday morning, when employees could be expected to be at home with television sets available. This also was several hours before the station normally opened up its day of public programs, eliminating the likelihood of an outside audience. But for the benefit of any dial twisters, who might tune in by accident, one of the station's regular announcers opened the show with a word of explanation and, incidentally, a very good TV commercial. "Northrop is known as a good place to work."

From his office in the Northrop corporate headquarters, and reading from a teleprompter, Collins delivered a detail report of about 3,500 words on the company's general outlook. Northrop made sure its own employees were aware of the program by distributing reminders of the time and station with pay checks the day before.

The television time cost $975. To cost-conscious Northrop this meant a saving of at least $1,000. A letter mailing, at a minimum of 10¢ a mailing, would have cost not less than $2,000 for the company's 20,000 employees. But more important was employee reaction. The response was outstanding.

In the earlier days of the company, John K. Northrop, when he had something to report to employees, used to cover all areas and all shifts with about a dozen speeches. This was a difficult job, but the effort paid off in increased employee loyalty and efficiency. Northrop is too big for this now. So the Northrop industrial council turned to television as the next best means of a personal approach.

Significant items in the Collins report: Northrop's performance has been good . . . We are in the middle of a belt-tightening period . . . Top command in the Air Force is beginning to understand the value of the *Snark*, "a very low-cost weapon," and Northrop hopes for reorders which will extend production beyond 1960 . . . American Bosch Arma is a good company and Northrop is hopeful of a "happy marriage."

Another union has its eye on the missile industry, the International Brotherhood of Electrical Workers. It has formed a new Los Angeles local to organize electronic technicians in this field. This union is now the bargaining unit for maintenance electricians at Convair, Douglas, Hughes, Lockheed and North American, where, incidentally, it has been unusually successful in negotiating higher job classifications, at higher rates, for its members.

The IBEW tried last year to organize portions of the Astronautics division of Convair from the International Assn. of Machinists, but was denied an election by the NLRB. The new Local 250, apparently, will attempt to organize unorganized electronic companies. Three organizers, "well financed," will be assigned to this area, says IBEW International Representative Charles Hughes.

contract awards

LAST MINUTE AWARDS

U.S. Army Signal Corps gave $294,000 to **Avion Division of ACF Industries, Inc.,** for production of x-band radar beacons to be used in missiles and missile drone test firings to extend the tracking range of ground radar.

Technical Products Division of Waste King Corp., Los Angeles, Calif. received $300,000 for manufacturing heat exchangers.

The Power Equipment Division of Jeta Metal Fabricators Inc., of Yonkers, N.Y., has been awarded additional government contracts to supply engine generating plants and related equipment to Armed Force installations.

Martin Co. gave Clary Dynamics Division of Clary Corp. a contract for development and production of propellant valves.

By Commander, HQ, AMC, Wright-Patterson:

Lockheed Aircraft Corp. received $598,997 for MB-1 weapons flight test program.

Northrop Aircraft, Inc., Northrop Div., Hawthorne, Calif. received $18,691,384 for research, development and flight test SM-62 weapon system.

Goodyear Aircraft Corp., Akron, Ohio, received $1,787,360 for modification of B-57 aircraft to TM-76A missiles.

North American Aviation, Inc., Missile Development Div., Downey, Calif. received $500,000 for conducting high performance X-10 drone flights to demonstrate weapon capability of the IM-99 *Bomarc,* including maintenance, inspection, overhaul and preparation for flight of X-10 vehicles with related ground support equipment.

By Middletown Air Materiel Area:

Dye Oxygen Co., Phoenix, Arizona, received $43,650 for liquid oxygen.

Union Carbide Corp., Linde Co. Div., New York 17, N.Y. received $116,002 for liquid oxygen.

By Comdr. HQ AMC, Wright-Patterson AFB:

Marquardt Aircraft Co., Van Nuys, Calif. received $234,611 for services to accomplish additional testing of RJ43 ramjet engine.

ARMY

By Ordnance District, St. Louis:

Pitman Mfg. Co., Kansas City, Mo. received $173,784 for truck, missile, maintenance, mobile high reach.

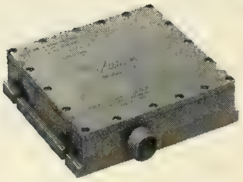
By HQ Redstone Arsenal, Ordnance Missile Command:

Raytheon Mfg. Co., Waltham, Mass. received $62,160 for technical assistance for guided missile school instruction.

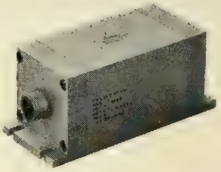
Associated Aero Science Labs, Inc., Hawthorne, Calif., received $119,516 for

DESIGNED TO FLY

Especially designed to meet the rigid size and weight requirements of airborne instrumentation, Statham's new strain gage carrier amplifiers are transistorized throughout. Operating from normally available 28-volt DC excitation, these units supply excitation to any strain gage transducer of desired range, amplifying and demodulating the transducer's low-level signals to provide an output of from 0 to 5 volts DC. When you require unprecedented accuracy and reliability in the amplification of signals from your strain gage instrumentation, specify a Statham strain gage amplifier.



Model CA3 Strain Gage Amplifier



Model CA5 Strain Gage Amplifier

EXCITATION: 28 volts DC, ±5%
OUTPUT: 0-5 volts DC
FREQUENCY RESPONSE: Flat from 0 up to 2000 cps
NON-LINEARITY AND HYSTERESIS: ±½%
OPERATING TEMPERATURE: −65° to +165°F.
OUTPUT IMPEDANCE: 10K ohms (100K recommended load)
WEIGHT: 14.5 ounces, approximately

For complete technical data, write to:

See you at Booth 944
I.S.A. Show, Sept. 15-19

Statham

INSTRUMENTS, INC.
12401 W. Olympic Blvd., Los Angeles 64, California

Circle No. 32 on Subscriber Service Card.

echnical assistance for guided missile chool instruction.

By Signal Supply Agency:

Edgerton, Germeshausen & Grier, Inc., Boston, Mass., received $683,985 for re-earch work for design of experiment in connection with radiation effects on elec-ronic devices, and on radiation monitor-ng systems.

Philco Corp., Philadelphia, Pa., received $2,469,381 for engineering design proposals for radar reconnaissance systems.

By Army Map Service, Corps of Engineers:

Product & Industrial Engineering Corp., Washington, D.C. received $40,139 for opographic map engraving, western U.S.S.R.

Alexandria Drafting Co., Alexandria, Va., received $38,220 for topographic map engraving, western U.S.S.R.

Artcraft Co., Quincy, Ill. received $71,750 for topographic map engraving, China (Chekiang).

By HQ, Quartermaster Research & Engineering Command:

Birdair Structures Inc., Buffalo, N.Y. received $139,493 for air supported shelter, "Pentadome."

Lowell Technological Institute Research Foundation, Lowell, Mass. received $25,000 for influence of dyeing and finishing processes on fiber properties of polyamide.

The University of Buffalo, Buffalo, N.Y. received $28,541 for development of chemical resistant rubber from semi-organics for use at extreme low temperatures.

By Pittsburgh Ordnance District:

Spencer-Safford Loadcraft, Inc., Augusta, Kansas, received $713,905 for trailer, 762mm rocket, 4 wheel XM405E1 128, publication and engineering drawings.

By Corps of Engineers, Office of the District Engineer:

Buchi Plumbing Co., Nashville, Tenn. received $39,939 for furnishing and installing cooling systems for miscellaneous equipment for the supersonic circuit of the propulsion wind tunnel.

NAVY

By Purchasing Office:

University of Dayton, Dayton, Ohio received $65,000 for services and materials required to make photographic measurements and to supply the data on IBM cards and to prepare reports related to the determinations of flight data for aircraft and missiles.

By Officer in Charge of Construction, Potomac River Naval Command:

Nicholson Engineering Co., Inc., Washington, D. C., received $179,887 for conversion of anechoic room to computer facility at the Naval Ordnance Lab.

AIR FORCE

By AFOSR, ARDC:

University of Miami, Coral Gables 46, Fla. received $50,624 for continuation of research on "Nuclear Emulsion Studies."

University of Virginia, Charlottesville, Va. received $38,777 for continuation of research on nuclear interactions of 25-75 mev photons.

New York University, New York 3, N. Y. received $51,036 for research on "High-Speed Gas Dynamics."

University of Pennsylvania received $32,000 for photonuclear reaction studies.

Digitron Changes Name to Computor Equipment Corp.

Digitron, Inc. has changed its name to Computer Equipment Corp., in order to identify the nature of its business.

The company, established in October 1957, is engaged in the development of advanced hybrid electronic systems. It recently announced receipt of a contract from Holloman Air Development Center to develop an electronic function plotter.

Air Logistics Acquiring Polaris Engineering Co.

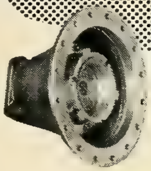
Air Logistics Corporation of Pasadena is acquiring Polaris Engineering of Inglewood as a subsidiary. Located in Pasadena, the new subsidiary will be known as Metrolog Corp.

Dr. Charles J. Breitwieser and Dale

Buckeye

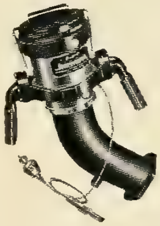
KEEPS THE PRESSURE ON

FUEL SERVICING



ADAPTERS

- Tapered seat, self-centering, cannot cock. Internal contour provides *maximum flow with minimum pressure loss.*
- Provide the most efficient form of connection for single point fueling.
- Type A-5, with one of several variable housings shown. Types A-2, A-3, A-4, and A-6 also available.
- All adapters meet General Specification MIL-A-6425A.



COUPLING VALVES

- Self-sealing coupling valves mate with adapters shown above to make positive leakproof connection for transfer of fuel. Full flow, minimum pressure drop.
- Valve can be connected or disconnected under pressure without loss of fuel.
- Type D-1, illustrated, meets Specification MIL-N-5877A.
- Other styles available.

BUCKEYE IRON & BRASS WORKS
DEPT. MR, BOX 883, DAYTON 1, OHIO

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*Name*________________

*Title*________________

*Company*________________

*Address*________________

*City*________________

*State*________________

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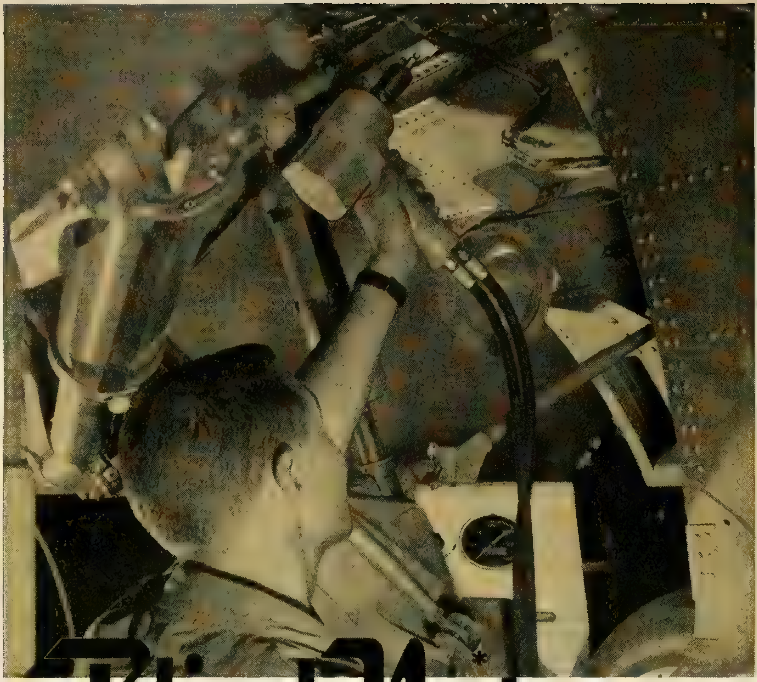
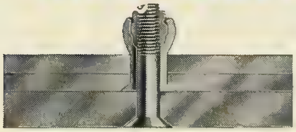


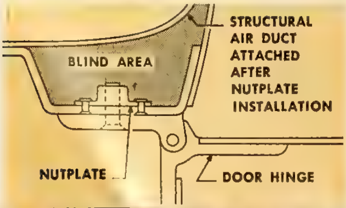
Blind Nut* FIX

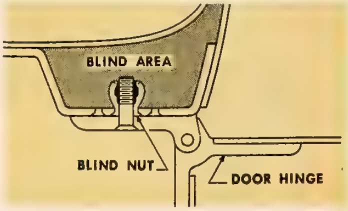
KEEPS AN F-104 ON SCHEDULE



Two damaged nutplates attaching the main landing gear door hinge to the fuselage threatened to keep a completed F-104 from entering final inspection. A conventional repair would have required the removal of a structural air duct to gain access into the closed-out area to replace the nutplates.

Blind Nuts were selected for the fix. The nutplates were drilled out, the holes were drilled slightly larger to accept the Blind Nut O.D. and the Blind Nuts were installed. The fix was successfully completed in a few minutes, a time consuming and expensive repair was eliminated and the Starfighter moved on schedule into final inspection.





By adding a core bolt to the Blind Nut's two piece basic configuration, this versatile fastener becomes a Blind Bolt suitable for use in tight quarters for production, modification or repair work in aircraft and missile structures. Stainless steel Blind Nuts and Blind Bolts are quietly installed by one man using a hand-held, hydraulically-operated gun.

Learn how Blind Nuts and Blind Bolts can answer your tough fastener problems — write for our Brochure.

U. S. PATENT PENDING, FOREIGN PATENTS GRANTED AND PENDING *TRADEMARK

hi-shear RIVET TOOL COMPANY
2600 WEST 247TH STREET • TORRANCE, CALIFORNIA

H. Demmott, former partners of Polaris Engineering, will continue as active management of the corporation which will develop and manufacture electronic instrumentation and specialized components for automation and automatic control systems.

Thiokol Announces Financing Proposal

Thiokol Chemical Corp. has requested Securities and Exchange permission on registration of 113,500 shares of its $1 per capital stock to be offered for subscription by holders of its outstanding capital stock at the rate of one new share for each 12 shares held. The record date, subscription price, underwriting terms and names of the underwriters will be supplied later.

Thiokol said net proceeds of the financing would be used for general corporate purposes, including expansion of its Utah Division which, it is anticipated, will involve expenditures approximating $4.5 million during 1958-59.

In addition, Thiokol is also considering the sale to one or more institutional investors of from $5 million to $7 million of 15-to-20 year unsecured notes.

Bendix Gets $1.75 Million *Bomarc* Fuze Contract

The York Division of Bendix Aviation Corp. has been awarded a $1.75 million contract to develop and produce a warhead proximity fuze for the *Bomarc* IM-99B guided missile.

The IM-99B *Bomarc* is an advanced version of the pilotless interceptor developed by Boeing for Air Defense Command.

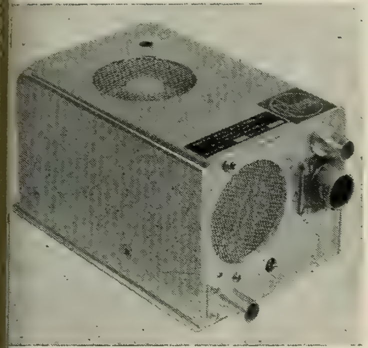
Howard Walker, Bendix-York divisional general manager, said the newest version of the *Bomarc* is to have improved performance in most of its characteristics—particularly in range—over initial *Bomarc* missiles.

Bendix-York has also developed, and is now producing, an instrumentation beacon used in testing the present *Bomarc* series, IM-99A. In test flights from Cape Canaveral, the beacon extends the range and accuracy of ground instrumentation radar, to enable the missile range safety officer to determine the exact position of the missile in flight.

The missile is equipped with its own target-seeking system, and can be equipped with either a conventional high-explosive or nuclear warhead, the company announcement said. The new fuze presumably will be adapted to either type of warhead.

Circle No. 33 on Subscriber Service Card.

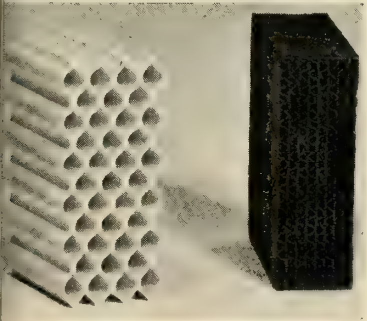
iniaturized Power mplifier Developed



A ruggedized, miniature R-F power mplifier only 5-1/3 inches by 3½ x 3 ches, increases signal power signifi-antly in the 215 mc to 260 mc tele-etering band. The model REL-10, eveloped by Rheem Manufacturing o., Electronics Div., can be used with ost presently available FM transmit-ers and delivers from 10 to 100 watts f R-F power with 2 watts of drive. he tiny high-output unit is exception-lly reliable in adverse environments f shock, vibration, and temperature nd features a self-contained cooling ystem. It meets the environmental re-uirements of missileborne instrumen-ation systems.

Circle No. 299 on Subscriber Service Card.

Corrugated Ceramics Give High Performance



Development of an entirely new eramic construction, by Minnesota Mining & Manufacturing Company, has dded a new degree of freedom in eramic technology.

The company said that new construction techniques provide high performance at extremely high temperatures, which permit for the first time he production of ceramic heat exchangers, ceramic catalyst supports, and ightweight structural units—construc-ions which heretofore could be made only of metals.

However, although the ductility of metals permits them to be rolled and formed into intricate shapes, the new ceramic concept adds the same degree of freedom of fabrication to ceramics. It is expected that the new ceramic construction will significantly increase the operating temperature range of systems in which heat exchangers are used; thus making feasible applications which could not be achieved previously because of corrosion and temperature limitations.

Circle No. 298 on Subscriber Service Card.

New Pocket-Size Oscilloscope Developed

Waterman Products Co., Inc., has developed a pocket-size oscilloscope with direct-reading features. Dubbed the "Pocketscope" high gain model, S-17-A is reported to incorporate new techniques that allow large-scope performance to be gained from the compact model.

Weighing less than eight pounds, the unit measures 4¾" high, 5½" wide and 10" deep. Simplified controls allow operation through use of two controls with automatic synchronization.

The direct-reading feature allows

UPWARD

Dramatic achievements are taking place at CROSLEY. Opportunities for engineers have never been greater than they are today. As man presses upward, civilization's horizons are expanding. What part will YOU play in our race to the "stars"?

CROSLEY'S contributions to these advanced programs are in the design and development of many important electronics' breakthroughs and accomplishments. The full story of CROSLEY'S growth plans is yours for the asking. Find out how YOU can participate in the space world of tomorrow.

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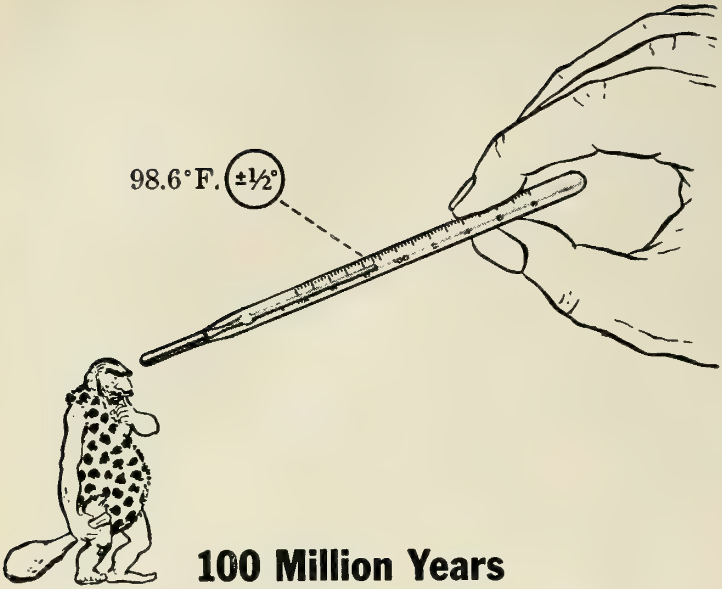
1329 Arlington Street-Cincinnati 25, Ohio

DEPT. 28



100 Million Years for System Development of Man's Marvelous Temperature Control

COX SYSTEMS GIVE CLOSER CONTROL WITH ULTRA-RELIABLE, FAIL-SAFE ELECTRIC HEATERS

Cox has designed more than 2000 different successful temperature control installations.

Cox has delivered more than 300,000 units for military service.

ADVANCED THERMAL ENGINEERING
plus
COMPLETE LABORATORY FACILITIES
plus
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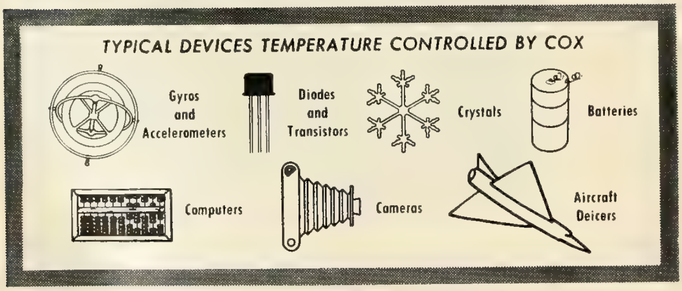

The Tougher the Problem...The Better We Like It!

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Engineering Representatives in Most Areas

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direct calibration of scales in volts (from 10 millivolts per division) and milliseconds (from 10 milliseconds per division). Sync signal in excess of 1 volt peak automatically triggers the oscilloscope.

Circle No. 297 on Subscriber Service Card.

Exotic Liquid Filters Resist Corrosion

Filters for exotic fuels and components; including hydrogen peroxide, hydrozine, ethylene oxide and liquid oxygen are now available from Micro Metallic Division of Pall Corporation.

The filters are designed with materials selected for corrosion resistance, plus elimination of dead thread spaces and unvented pockets. They are said to provide the utmost in safety and reliability in systems of unstable liquids. The metallic filter medium used permits construction that can withstand full system pressure, in the event of clogging without collapse of the element.

The largest filters can handle 5,000 g.p.m. of liquid oxygen, removing all particles over 40 microns in size. Smaller elements can filter 30 lbs. per minute of nitrogen, with a 10 micron particle size retention rating.

Circle No. 296 on Subscriber Service Card.

Two Types of Drift-Free Strain Gages Introduced

Research scientists of the High Temperature Instruments Corp. of Bala Cynwyd, Penn., have announced development of two new types of strain gages said to be capable of withstanding high temperatures.

According to a company announcement, one gage type (HT-600) is drift-free up to 600 deg. F. The HT-1200 has been tested at temperature to 1,000 deg. F, without apparent drift.

The instruments are a combination thermocouple and strain gage. The thermocouple hot junction is located in the plane of the grid permitting precise monitoring of gage temperatures. Zero-shift correction charts can be used in strain determinations, with a high de-

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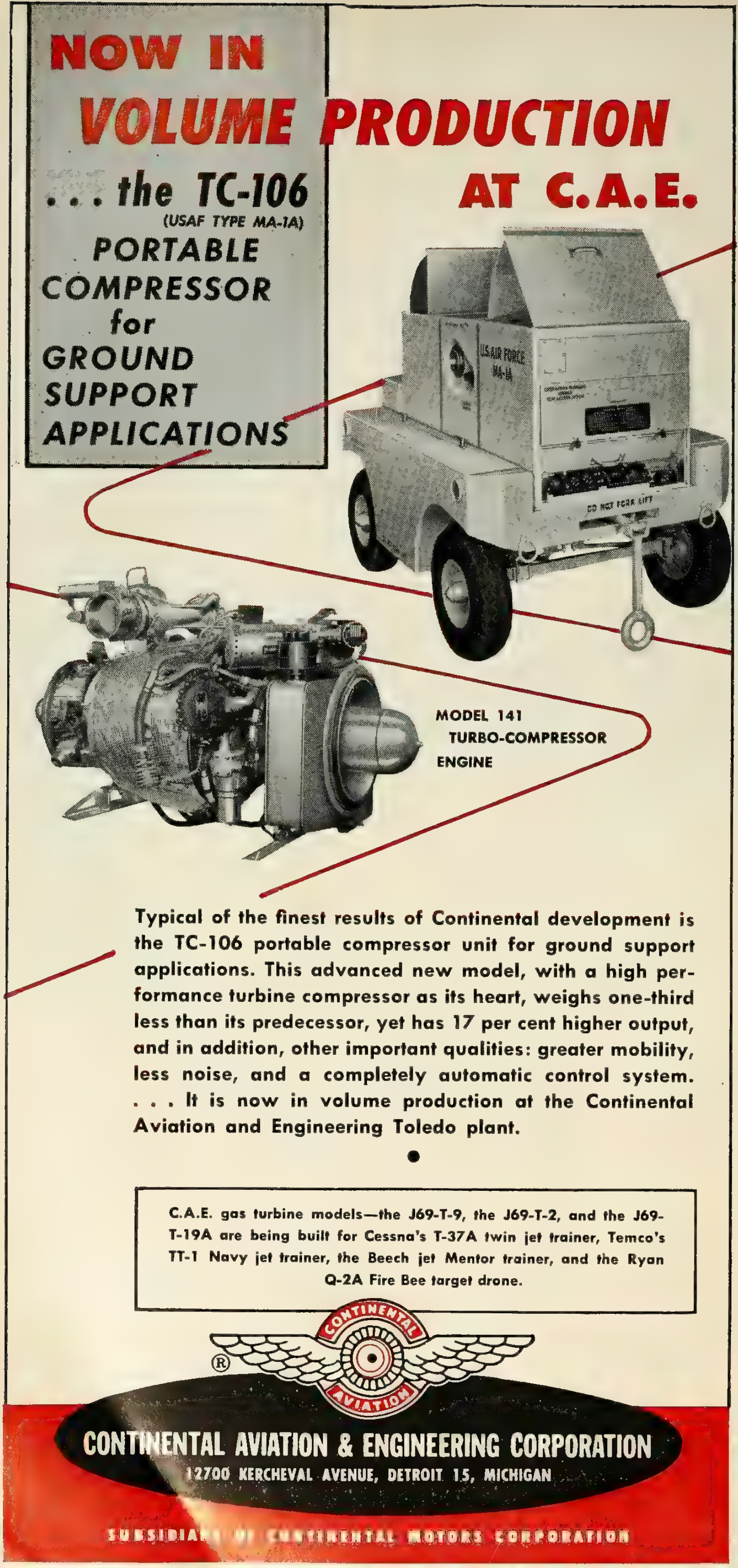

NOW IN
VOLUME PRODUCTION
AT C.A.E.
. . . the TC-106
(USAF TYPE MA-1A)
PORTABLE
COMPRESSOR
for
GROUND
SUPPORT
APPLICATIONS

Typical of the finest results of Continental development is the TC-106 portable compressor unit for ground support applications. This advanced new model, with a high performance turbine compressor as its heart, weighs one-third less than its predecessor, yet has 17 per cent higher output, and in addition, other important qualities: greater mobility, less noise, and a completely automatic control system. . . . It is now in volume production at the Continental Aviation and Engineering Toledo plant.

●

C.A.E. gas turbine models—the J69-T-9, the J69-T-2, and the J69-T-19A are being built for Cessna's T-37A twin jet trainer, Temco's TT-1 Navy jet trainer, the Beech jet Mentor trainer, and the Ryan Q-2A Fire Bee target drone.

CONTINENTAL AVIATION ®

CONTINENTAL AVIATION & ENGINEERING CORPORATION
12700 KERCHEVAL AVENUE, DETROIT 15, MICHIGAN
SUBSIDIARY OF CONTINENTAL MOTORS CORPORATION

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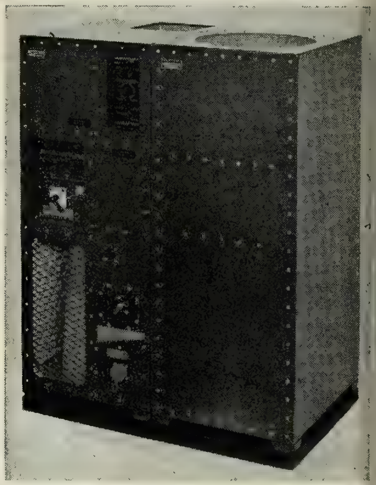
gree of accuracy, the company adds.

The instruments are available in miniature, but standard size is 1/8 in. x ¼ in.

Circle No. 295 on Subscriber Service Card.

Small Air Conditioner Used For Support Systems



A new, lightweight, 4½-ton capacity, vapor cycle air conditioning package for missile ground support systems—featuring a six inch compressor—has been developed for the U.S. Army Corps of Engineers by Stratos Division of Fairchild Engine and Airplane Corp.

Utilizing the small, rotary, positive-displacement compressor, which weighs only 10½ pounds, and aircraft type aluminum plate and fin construction condenser and evaporator, Stratos cut the size and weight of its unit to less than half that of comparable ground support air conditioning packages. Designated the VEA4-3, the air-conditioner weighs but 350 pounds, and is 40″ long, 24″ wide and 51″ high.

Circle No. 294 on Subscriber Service Card.

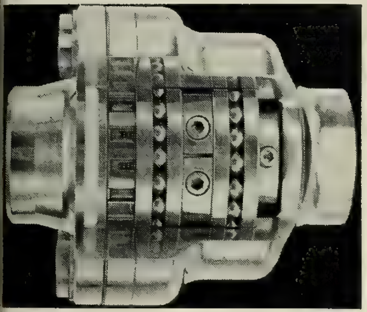
New Pressure Transducer Offered by Fairchild

A new miniaturized pressure transducer for guided missiles and high-speed aircraft is available from Fairchild Controls Corp. With total volume at only ¾″ and weighing less than 2 oz., the unit can be adapted to measure absolute, gage, or differential pressures in the range from 0-5 psi to 0-350 psi with a linearity of ±1%. Potentiometer output has a resolution of 0.25% in most pressure ranges.

The unit can operate at up to 2,000 cps at 15g with an output signal transmission error of less than 1%. It withtands 25g in the 10-2,000 cps range vith no damage or permanent calibraion shift. At acceleration force of 40g, he unit will operate with less than % error and can withstand 75g withut permanent damage or calibration hift.

Circle No. 293 on Subscriber Service Card.

yrogenic Swivel Joint s Self-Lubricating



Liquid oxygen and other liquefied ases circulate in the thrust bearing aces of this new swivel joint design, hus taking advantage of the lubricity f the fluid.

Other advantages of the new joint, ccording to the Chiksan Company, re improved temperature stabilization nd the absence of contaminating lubriants. Uniform spring tension against metal disc, which in turn exerts presure against a seal, is a principal packng feature. A plastic dust seal prevents ontamination from external sources. he swivel joint is said to provide low-orque freedom of movement on as nany planes as desired, through fabriation of elbows in combination with lane swivels.

Circle No. 292 on Subscriber Service Card.

ransistor Galvanometer or High-Frequency Use

A new high frequency galvanometer as been developed by the Edin Comany, Inc. for general use with tranistor powered amplifiers in oscillograph ecording applications. The ink-writing nstrument features flat frequency response from DC to 35 cps, and exended flat response up to 200 cps with compensated signal amplification.

Using a hi-speed D'Arsanvol armaure in the field of an Alnico V magnet, the device gains linear phase shift through the use of a single resonant system of pen and coil. The total DC coil resistance is 260 ohms, center tapped.

The stylus is mechanically centered and is retained by a simple spring clip.

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THE Quality LINE IN FITTINGS

2000 Lb., 3000 Lb. and 6000 Lb.
SCREWED and SOCKET WELD
STAINLESS STEEL FITTINGS

Special non-standard fittings furnished to order . . . One source for all your stainless fitting requirements.

Also available—150 lb. screwed fittings and all schedules of buttweld fittings.

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☐ Catalog Extra Heavy 657.
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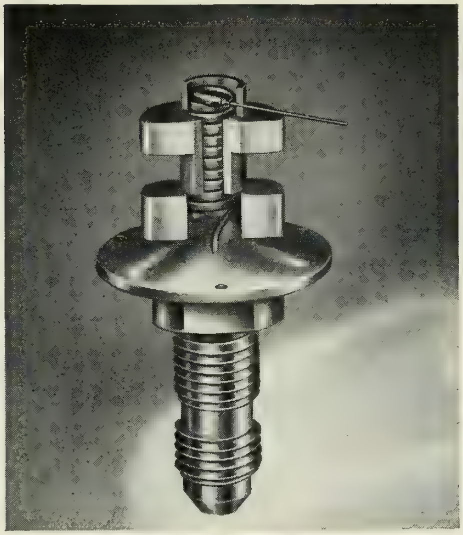
200,000 applications of pressure fail to shake this gauge's accuracy!



This is the exclusive Lindsay Bourdon Element which makes the RMC-Lindsay High Pressure Gauge capable of such tremendous cycling endurance. Each gauge is qualification tested to withstand up to 200,000 applications of pressure.

You can scratch cycling endurance problems from your high pressure gauge headache list with

RMC-Lindsay High Pressure Gauges

Specifically created for the extremely specialized demands of jet aircraft and missile pressure systems, this gauge is radically different from ordinary pressure gauges. The RMC-Lindsay gauge is a multiple coil, helical bourdon tube type; restricted for overpressure. The pointer is attached directly to the end of the coil, eliminating the use of linkages and pivots.

The bourdon principle itself is not a new development, but the RMC-Lindsay techniques in coiling, heat treatment, calibration and material specifications *are* new . . and *exclusive with RMC.* The Lindsay gauge was invented and developed by Mr. James E. Lindsay, now manager of engineering at RMC of California.

Whatever your high pressure gauge problems may be, why not let RMC engineering skill provide the answers. Write to either plant, or contact one of the RMC representatives listed below:

JOHN FEARON
Boiler Equipment Corp.
P.O. Box 8188, Station F
Atlanta, Georgia

DONALD TATE
Tate Engineering, Inc.
516 S. Eutaw Street
Baltimore 1, Maryland

CHARLES SHEA
J. H. Bertram & Co., Inc.
233 Harvard Street
Brookline 46, Mass.

ROCHESTER MFG. CO., INC.
12143 Halsted Street
Chicago 28, Illinois

RALPH M. NELSON
911 Marshall Bldg.
Cleveland 13, Ohio

HOWARD SNYDER
Benson Engineering Co.
2514 W. Mockingbird Lane
Dallas 35, Texas

J. NEILL ARMSTRONG
J. Neill Armstrong, Inc.
205 Sharrow Vale Road
Haddonfield, New Jersey

WILLIAM RUBLY
Rowe Sales Co.
2140 Westwood Blvd.
Los Angeles 25, Calif.

GEORGE GIBSON
J. Neill Armstrong, Inc.
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New York 17, New York

JOHN E. FAHRLANDER
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2902 W. 72nd Terrace
Prairie Village 15, Kan.

GORDON E. BENNETT
G. R. Schumann Co.
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San Francisco, Calif.

BEN J. GERKER
6625 Delmar Blvd.
St. Louis 5, Mo.

BARRY S. FOLEY
1718 Eye Street, N.W.
Washington 6, D. C.

J. H. BERTRAM
J. H. Bertram & Co., Inc.
998 Farmington Avenue
West Hartford 7, Conn.

DON W. BRUNER
Benson Engineering Co.
519 S. Broadway
Wichita 2, Kansas

RMC

ROCHESTER MFG. CO. OF CALIFORNIA
95 Beacon Place, Pasadena, California

ROCHESTER MANUFACTURING CO., INC.
223 Rockwood Street, Rochester 10, N. Y.

LINDSAY PRESSURE GAUGES

Circle No. 38 on Subscriber Service Card.

book reviews

SPUTNIK INTO SPACE by M. Vassiliev with V. V. Dobronravov, 181 pp., $3.75 The Dial Press, 1958, New York.

Originally published in Moscow by the State Publishing House in 1955 this book suffers from a number of errors in fact and translation. Part of this may be due to the fact that it was not translated from Russian, but from Italian, which in turn was from a Russian translation. However, there are instances of in-accuracies which are not justified on this basis.

The introduction is written by Mr. William Beller, who is listed on the dust jacket as former managing editor of ROCKETS AND MISSILES, a "technical publication". If the reference is to Missiles and Rockets Magazine, then the error is that Mr. Beller was never managing editor. If the reference is to the book ROCKETS AND MISSILES, then the error is that this book was authored solely by Erik Bergaust, executive editor of MISSILES AND ROCKETS magazine.

One of the irritating facts about SPUTNIK INTO SPACE is that it has been advanced with tongue in cheek as a post-*Sputnik* report on Soviet satellites and space-flight plans. Actually, the first (and as far as we can tell, the only) edition was published in 1955. This fact is not mentioned, except for one reference to it in the introduction.

Another statement is that the book was never meant to be read outside the Soviet Union, and the implication is that only a life-or-death struggle by a corps of secret agents provided us with a copy. In fact, m/r's international editor purchased a copy of the original Russian edition in a bookstore in August 1957. The book has been readily available in this country since late 1956.

Its content can be described simply: nothing new. Of the myriad space flight books now on the market, there are many that would provide a better basis for educating oneself in the field. This work's prime claim to fame is that its authors are Russian.

Errors in translation include the figure of 435 miles altitude for a *Wac-Corporal* launching, where the Russian version gave a figure of 480 kilometers. However, even 480 km. (298 miles) seems to be incorrect, since a peak altitude of 245 miles is generally accepted for this *Wac-Corporal*/V-2 combination. Also, where the Russian version mentions altitudes of 300 km., the English version gives 300 miles and the Russian data is not altered accordingly.

INDUSTRIAL GASES... NATIONWIDE... FROM AIRCO

Air Reduction gases, among them oxygen, nitrogen, argon, hydrogen, helium and carbon dioxide are vital commodities in the metal-working industries.

In other industries, too, Air Reduction gases are playing an important role—food processing, electronics, steel, aircraft and missiles, and chemicals.

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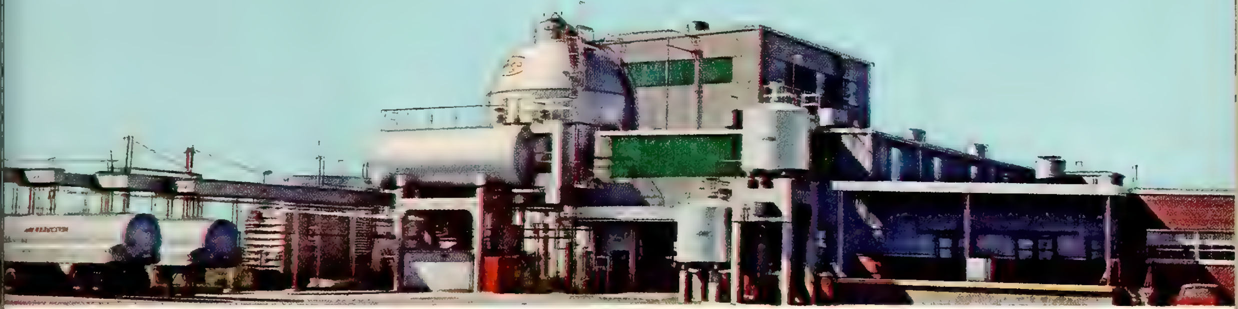

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NEW — DC Aircomatic Fillerarc — motor generator type — for out-of-position Aircomatic welding and for obtaining superior welds with Pureco's welding grade CO_2. Available in 450 Ampere Model.

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Air Reduction's arc welding machines are rugged, dependable, and designed to meet the power requirements of *any* arc welding job. Representative of the complete Airco line of many different power source combinations are five arc welders shown here.

NEW—AC/DC Heliwelder—engine driven type, air cooled—for inert-gas-shielded and metallic arc welding in the field. Available in 300 Ampere Model.

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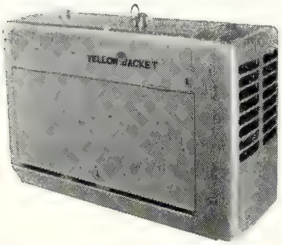
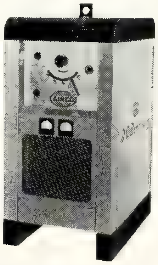


DC Yellow Jacket—engine driven type, liquid cooled—for heavy duty steel construction in the field. Available in 300 and 400 Ampere Models.



DC Bumblebees—Rectifier type—for general industrial welding. Available in 200, 300, 400 and 600 Ampere Models.

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WAR AND PEACE IN THE SPACE AGE by Lt. General James M. Gavin, 304 pp, $5, Harper & Brothers, N.Y.

A highly readable, thought-provoking study of how the Free World has fallen behind the Soviets both technologically and militarily. These are he beliefs of the man who resigned as the Army's chief of research and development.

"Space is the theater of the strategy of tomorrow—space and the human mind," writes Gen. Gavin. He adds that the real tragedy in efforts to close the gap is lack of understanding of the supreme significance of space.

For those concerned with determining the course and shape of missiles and techniques which will enable this nation to survive during what Gen. Gavin calls the "Decade of Decision" (1955-1965), the following points are of particular interest:

- Emphasis on the manned bomber is wrong. They will be replaced by ICBM's and IRBM's.
- There is a dangerous tendency to become so preoccupied with missiles as to overlook equally essential mobile ground handling equipment.
- Mobility (especially of missiles) should get the highest priority in our military programs.
- Nuclear weapons will become conventional tactical weapons.
- Air Force will have a manned reconnaissance satellite by 1965.

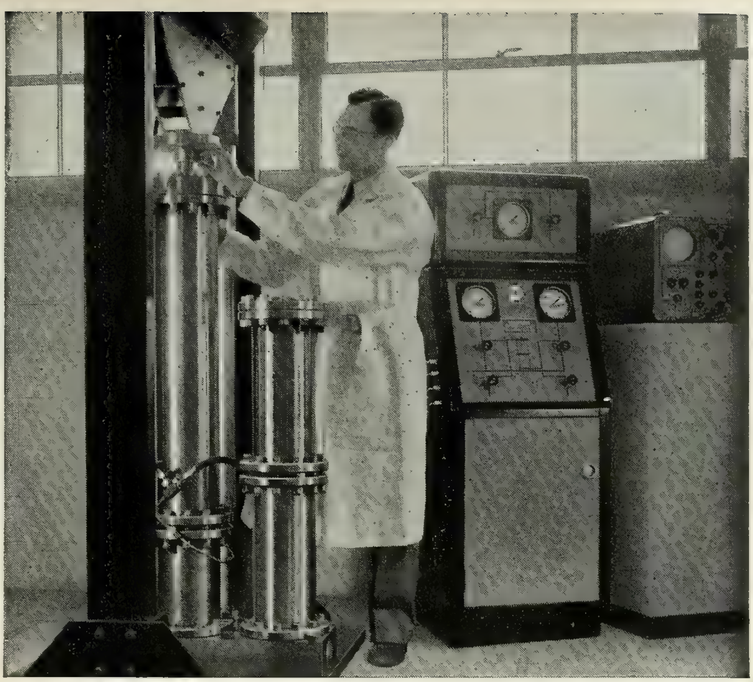
The General not only scores high decisions, which he says permitted the Soviets to forge ahead in the satellite and space fields, but says even the decisions themselves have been coming too late.

He especially criticized the system whereby a military man must appear before Congress and sell the program of his service, even if he frequently does not sincerely believe it to be in the best interest of the nation, but has been ordered to support.

Such was the decision Gen. Gavin faced. He answered with a resignation, and a private status where he feels he can best work for the weapons developments and long range space age requirements he believes necessary not only for the army, but for the nation.

Despite the gloomy present, Gen. Gavin says:

"I am of the personal conviction that the space age offers for the first time a real prospect of a lasting peace . . . if this planet is to remain inhabitable by man, a space program must be developed under the United Nations."



Hyge shock tester takes about 60 seconds to complete acceleration-shock test with up to 40,000 lbf. thrust. Hughes Products Memoscope® oscilloscope retains wave pattern as long as you like for careful study and comparison with master pattern.

High-g thrusts you can trust for controlled shock tests

You can produce predictable, repeatable acceleration-shock thrusts to 40,000 lbf. with Hyge

Hyge gives you an amazingly simple way to simulate actual service conditions for shock testing small and large assemblies.

Hyge gives you complete control over all variables. It ends the guesswork inherent in such devices as air cannons, impact hammers, and drop towers.

With Hyge you can accelerate a specimen to several hundred g's in just milliseconds with exact reproduction of preset half-sine, square, and sawtooth patterns.

How it works

Hyge is a piston in a cylinder which is divided by an orifice plate. Using nitrogen, you build up a small pressure against the top of the piston, sealing it to the orifice plate. You can then build up a very large pressure against the bottom of the piston, since you are working against only the small area exposed by the orifice. As soon as the pressure against the bottom overbalances the top pressure, the seal breaks and the whole piston bottom is exposed to the larger pressure. The piston is then thrust upwards at a tremendous speed.

Hyge transmits this thrust directly through a column to a test platform which rides on deceleration rails. Preselected metering pins control the thrust pattern, make it infinitely repeatable.

Free bulletin

Bulletin 4-70 gives you much more information on the theory and application of Hyge, including specifications and accessories for the HY-6000 Hyge and the smaller, 10,000 lbf. Hy-3000.

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STRAIGHT TALK TO ENGINEERS

from Donald W. Douglas, Jr.

President, Douglas Aircraft Company

I've been asked whether non-aeronautical engineers have good prospects for advancement in the aviation industry.

The answer is *yes, definitely!* At Douglas many of our top supervisory people have moved up from other engineering specialties. The complexity of modern aircraft and missiles requires the greatest variety of engineering skills known to industry.

For example, we now have pressing needs for mechanical, structural, electrical and electronics engineers in addition to aerodynamicists, physicists and mathematicians. Whatever your background in the engineering profession may be, there are prime opportunities in the stimulating aircraft and missiles field.

Please write to Mr. C. C. LaVene
Douglas Aircraft Company, Box 620-R
Santa Monica, California

keeping track

by Peer Fossen

According to reports from the IAF congress in Amsterdam, Russia is planning to give away 500 satellite tracking telescopes to foreign countries, including Argentina and Poland, to encourage the advancement of astronautics. According to IGY sources in Washington, the U.S. has been involved in a similar program for a long period of time. More than 100 moon-watch teams in foreign countries have received wide-angle telescopes from the U.S. Some of the countries involved are: Argentina, Australia, Belgian Congo, Chile, Japan, Mexico, Curacao, Peru, South Africa, Germany, and Iran.

First things first! Dr. Fred L. Whipple, at the IAF Congress, emphasized the need for an accelerated U.S. program to investigate the "mysteries" of the ultra-violet spectrum, between X-rays and visible light. To do this, Dr. Whipple suggested "shooting" a telescope into orbit, and concluded that "the time to do it is right now." One cannot help but question the merits of such a program at this time when the tremendous barrier of the radiation belt is creating a maximum amount of knowledge-searching for a plausible cause. Coupled with the radiation hazard is the inability of rocket engineers to control the temperamental actions of their power systems for such straightforward experiments as the determination of the existence, if any, of a magnetic field around the moon, or the rate of the decrease of the earth's magnetic field.

Advanced Research Projects Agency has reportedly given a feasibility study program to the Army's Ballistic Missile Agency for a 25,000-lb. satellite program. Confirmation of feasibility of the program was quick in coming from the Army's research team. The program is expected to be one of the United States' first attempts at placing a man in orbit for prolonged periods of time. Unless much larger power plants than are now in existence are utilized for this project, it will be necessary to cluster weapon systems such as the *Jupiter* IRBM.

Looks like Admiral Rickover and USAF are in the same boat. The fact that Admiral Rickover was not invited to the White House pomp and circumstance session in honor of the *Nautilus* under-the-ice cap voyage was given proper coverage in the nation's newspapers. However, another guest of honor was left off the invitation list, namely the United States Air Force. It was the USAF *Navajo* guidance system that enabled the *Nautilus* to make the trip in the first place.

And speaking of the Nautilus, a recent news story stated that, even in the event of war, there is no way to communicate with submarines which might be operating under the ice cap. This statement should give some impetus to the underwater long distance systems now being explored by the Bureau of Ships Division.

The Martin Co., Orlando, Florida, recently awarded a contract to Waste King Corporation of Los Angeles for the manufacture of LEV-3 gyro stabilizer systems for test versions of the *Pershing* missile. It is interesting to observe that the LEV-3, long ago described by Dr. Wernher von Braun as "the workhorse of missilery," is being relied upon to guide the *Pershing* during the test phases of the program. The LEV-3 was originally designed and produced in Germany for the V-2 missile. When von Braun's development team and its equipment was brought to the United States after World War II, a substantial number of LEV-3s formed part of the hardware. The current manufacturing price for this system is approximately $10,000. Systems claimed to be more refined cost many times that amount.

4 Ounce Contact Force Makes Relays More Reliable

Contact force of 4 ounces per contact on 50 "G" models and 2 ounces per contact on 30 "G" models of "Diamond H" Series R and Series S miniature, hermetically sealed, aircraft type relays is one of the most important factors in their proven high reliability.

Though absolute reliability of any similar device is impossible to guarantee—a bitter fact of life recognized by all electronic engineers—close approach to this goal by the relays manufactured by The Hart Manufacturing Company is the basic reason they are found today on many of this country's headline-making missiles.

In addition to contact force far beyond that found on other relays, "Diamond H" relays have greater contact cleanliness. Self-contamination is virtually eliminated by a completely inorganic switch mechanism, as well as use of coil materials which will not dust, flake or out-gas.

Finally, the high degree of reliability that is designed into these relays is maintained in their manufacture by high quality workmanship and a stringent inspection policy at every stage.

In addition to missiles, and their ground control systems, Series R and S relays are designed for use in jet engine controls, computers, fire control, radar and similar critical applications.

4PDT units, they offer an extremely broad range of performance characteristics, including temperature ranges from —65° C. to 125° and 200° C.; ratings to 10 A., 120 V., A. C., and 26½ V., D. C., with special ratings to 400 ma. at 350 V., D. C., or down to millivolts and milliamperes. Dry and wet circuits may be safely inter-mixed.

For more information, write today for Bulletins R250 and S260. For quick facts about "Diamond H" switches, thermostats and other devices, ask also for a copy of the "Diamond H" Check List of Reliable Controls.

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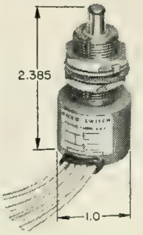
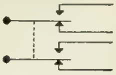
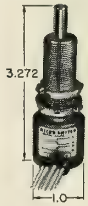


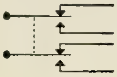


1EN1-6

(MS-24331-1)

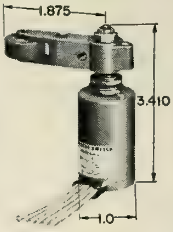
Plunger actuator with ice scraper ring. In sealed enclosure are two SPDT subminiature basic switches. Operating force 6-12 lbs.; release force 4 lbs.; overtravel—.250 in. Rating: 28vdc 24a. inrush; 4a. resistive; 3a. inductive. Weight—2.5 oz.

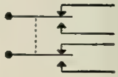




1EN61-6

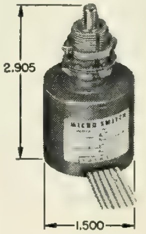
The longer bushing provides maximum adjustment range of operating point. Overtravel—.500 in. DPDT circuitry and capacity same as 1EN1-6.

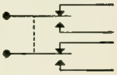




31EN1-6

Adjustable spring-return rotary actuator. Contains two "SM" switches (See 1EN1-6). Operating torque 30 in. lbs.; release torque 9 in. lbs.; total travel 45°.

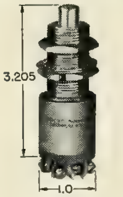


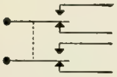


2EN1-6

(MS-24331-2)

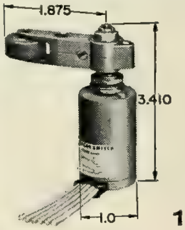
This DPDT assembly contains two SPDT high capacity "V3" type switches. Rating: 28vdc—36a. inrush; 10 a. resistive; 6a. inductive. Operating force—6 to 12 lbs.; release force—5 lbs.; overtravel—.250 in. Weight 5.5 oz.

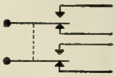




12HR1-S

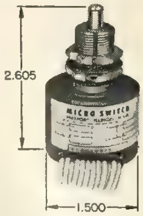
Hermetically sealed, high temperature DPDT switch for reliable use to 600° F. Metal-to-metal & glass-to-metal seals in accordance with Par. 5.2.2, MIL-E-5272A. Ice scraper ring on actuator. Rating 28vdc-5a. res.; 2a. ind. Operating force 6-12 lbs.; release force 5 lbs.; overtravel—.250 in. Weight 4.5 oz.

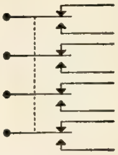




131EN1-6

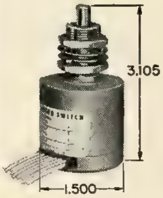
Special high temperature construction for up to 250° F. Adjustable spring return rotary actuator. DPDT. For rating see 1EN1-6. Operating force 30 in. lbs.; total travel 45°; differential travel 6°. Weight 2.65 oz.

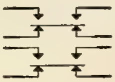




5EN1-6

A 4-pole DT assembly with 4 SPDT "SM" basic switches sealed in enclosure only 1½" dia. Mechanical characteristics same as 1EN1-6 except differential travel. 28vdc—24a. inrush; 4a. resistive; 3a. inductive. Weight 4.25 oz.

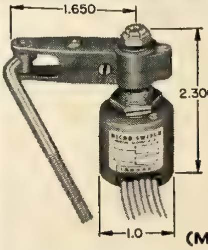


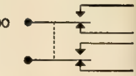


4EN1-6

(MS-24331-4)

Sealed within the 1½" dia. enclosure is one 4-circuit double-break "TB" series switch. Rating 28vdc—30a. inrush; 15a. resistive; 10a. inductive. Operating force—6-12 lbs.; release force—5 lbs.; overtravel—.250 in.





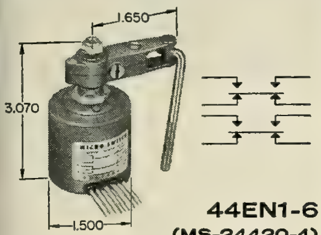
41EN1-6

(MS-24420-1)

Has rotary actuator with linkage for positive drive and release. Lever arm adjustable through 360°. Two SPDT "SM" switches in sealed enclosure provide DPDT circuitry. Operating torque—3 in. lb.

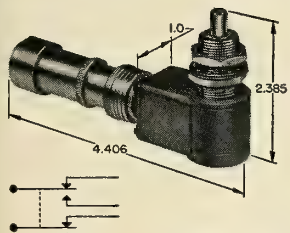
Switches have uses unlimited

350 Functions in Aircraft...
Marine and Ordnance Applications



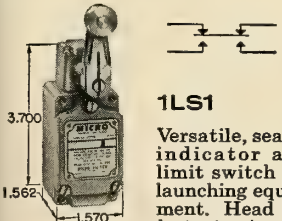
44EN1-6
(MS-24420-4)

Rotary actuator arm adjustable through 360°. Contains one 4-circuit basic switch. Rating 28 vdc—30a. inrush; 15a. resistive; 10a. inductive. Operating torque —10 in. lbs.



1EN42-R

A special design for high shock applications. Contains two SPDT switches. See 1EN1-6. Quick disconnect connector.



1LS1

Versatile, sealed indicator and limit switch for launching equipment. Head adjusts to 4 positions; arm adjusts through 360°; operation adjusts to either or both directions. Two-circuit basic switch. Rating: 10a. 120, 240, 480vac. Operating force 3 lbs.; release force ½ lb.; overtravel 30°.

For many years, MICRO SWITCH's Airborne Projects Group have been answering your questions and helping you solve difficult problems by cooperative engineering help and a readiness to design special switches for you.

The twelve "EN" Series switches illustrated in these pages are the outgrowth of one switch. The "EN" Series has now grown to a point where the series consists of ninety-four different switches actually in use—an original concept by the Airborne Projects Group at MICRO SWITCH.

"EN" switches are completely sealed against the effects of changes in atmospheric conditions in enclosures filled with inert gas under pressure. Each switch is fabricated under rigid manufacturing procedures, and tested on a mass spectrometer. The actuator mechanism operates through a seal that maintains pressure and keeps dust and moisture out. A scraper ring on the actuator shaft prevents jamming or binding even in ice or mud . . . Your request for catalog 77 and data sheets 122 and 138 will be responded to promptly.

MICRO SWITCH . . FREEPORT, ILL.
A division of Honeywell
In Canada: Honeywell Controls, Ltd.,
Toronto 17, Ontario

The two-word name MICRO SWITCH *is* NOT *a generic term. It is the name of a division of Honeywell.*

Look in the Yellow Pages for the name of the branch office and sales engineer nearest you.

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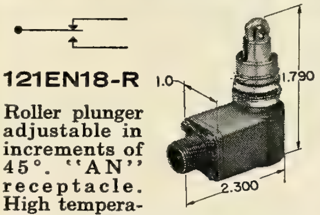
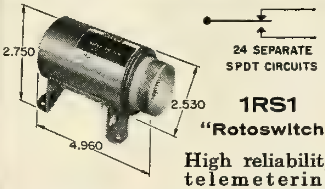
Honeywell
MICRO SWITCH PRECISION SWITCHES



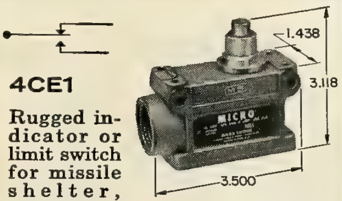
121EN18-R

Roller plunger adjustable in increments of 45°. "AN" receptacle. High temperature construction for up to 250° F. Contains two gold-contact "SM" switches. Characteristics same as 1EN1-6.



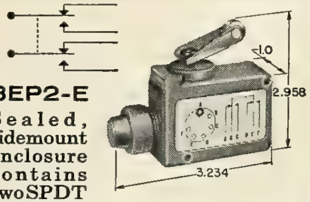
1RS1
"Rotoswitch"

High reliability telemetering switch for missile program sequencing. Hermetically sealed enclosure contains rotary solenoid and 24 SPDT gold-contact "SM" switches.



4CE1

Rugged indicator or limit switch for missile shelter, erecting and launching equipment. SPDT. Rating: 10a. 125vac; 5a. 250vac. Operating force 6-10 lbs.



3EP2-E

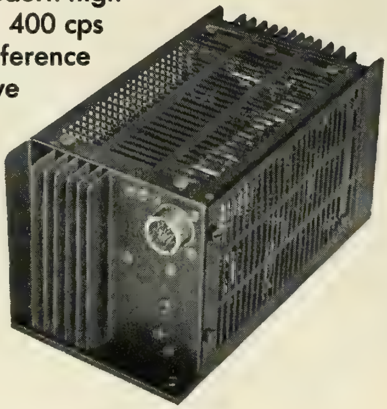
Sealed, sidemount enclosure contains two SPDT high capacity switches. Sealed receptacle. Rating: 28vdc-36a. inrush; 10a. res.; 6a. ind. Operating force 4-6 lbs.; release, 2 lbs.

Circle No. 41 on Subscriber Service Card.

TRANSISTORIZED POWER SUPPLY by CANOGA

A new lightweight power supply for the AN/ARN-14 Navigation Receiver has recently been developed at Canoga. It provides closely regulated 28 VDC and 260 VDC with a minimum size and maximum of reliability.

This unit is designed for modern high performance aircraft using 400 cps power systems. Radio interference and transient problems have been held well below minimum specification requirements. Fully transistorized conservative design has resulted in an unusually rugged, compact, and highly reliable unit.



PERFORMANCE SPECIFICATIONS

INPUT VOLTAGE: 200 VAC 3ϕ, 320-480 cps
OUTPUTS: *(1)* 28 VDC, 0-3 Amps, 1% Regulation, 0.5% Ripple and Noise
(2) 260 VDC, 0-150 ma, 0.15% Regulation, 0.02% Ripple and Noise, Output Impedance less than 10 ohms DC to 1 mc
TRANSIENT LIMITS: LINE: 400 VAC
LOAD: 28 VDC Supply — 12 Amps
260 VDC Supply — 0.5 Amps
AMBIENT TEMPERATURE: −55° C to +55° C, Intermittent Operation to +71°C
MIL SPECS: MIL-E-5400A, MIL-E-5272A, MIL-I-6181B
UNIT DIMENSIONS: Length 7½", Height 3¹³⁄₁₆", Width 4"
WEIGHT: 4.5 pounds

May we have the opportunity of applying our design and production know-how to assist you in solving other power supply problems of larger capacity or higher precision.

- ANTENNAS
- RECEIVERS
- RADAR SYSTEMS
- TEST EQUIPMENT
- MICROWAVE COMPONENTS

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m/e news

New Highs Recorded For TV-Electronics Fund

Net assets of Television-Electronics Fund, Inc., a mutual fund concentrating investments in the field of electronics and nucleonics, totaled $178 million on July 31, a new record and at a level 32.1% above its resources of $135 million on October 31, 1957.

According to president Chester D. Tripp, at the end of the Fund's third fiscal quarter, ended July 31, 95.2% of its assets were invested in common stocks and convertible securities in the electronics field, compared with an 86.9% equity position nine months earlier.

Contest Announced For Miniaturization Advances

Nominations for the 1958 Miniaturization Award competition, established in 1957 by Miniature Precision Bearings, Inc., are now being accepted.

The award recognizes outstanding contributions by an individual or firm to the concept of miniaturization. It consists of an original sculpture symbolizing miniaturization, to be presented March, 1959. Certificates of Merit will also be awarded for outstanding contributions. Selection is by an independent committee of miniaturization experts representing industry, government and education.

According to Mr. Horace D. Gilbert, president of Miniature Precision Bearings, Inc., the award was conceived as "a means of stimulating activity within industry to promote the concept of miniaturization." He urged all companies that are involved in miniaturization to participate in the competition.

In order to be considered for an award; products, components, or parts should show outstanding ingenuity in the solution of problems; make use of new design concepts and special materials; or indicate development or use of new type components or parts that extend the frontiers of miniaturization.

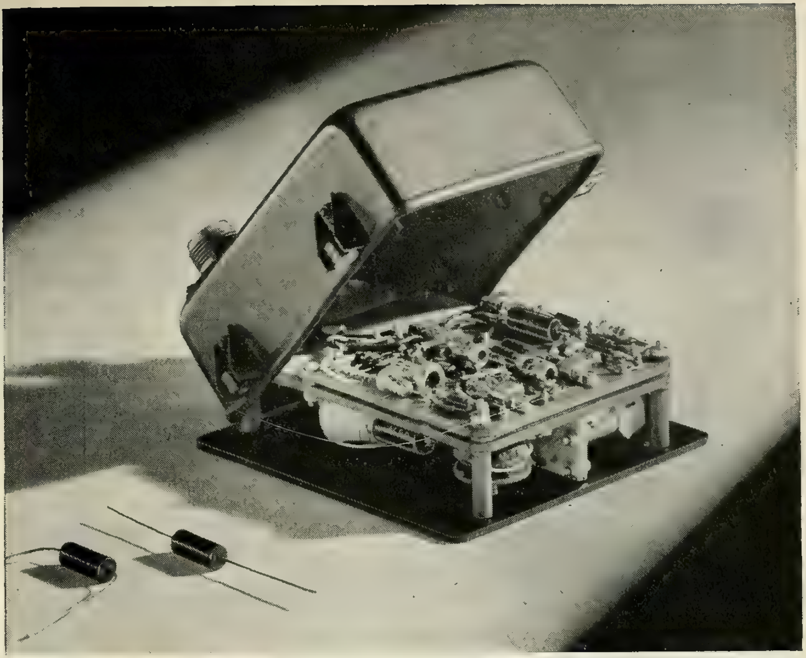
Participants in the competition may be individuals, companies or organizations which have broadened the horizons of miniaturization by creating a better understanding and use of the concept through education, research, engineering or standardization.

Entries should be submitted to the Awards Committee, Box 604, Precision Park, Neene, New Hampshire.

The 1957 Miniaturization Award was presented to Diamond Ordnance Fuze Laboratories for its development of photolithographic printing tech-

Circle No. 42 on Subscriber Service Card.

Airborne Miniaturized Mylar* Capacitors help **reduce weight and bulk** in electronic packages



Amplifier for oil temperature servo control system utilizes Airborne miniaturized "Mylar" capacitors to save weight and insure high reliability. Entire system, including rotary actuator, is Airborne produced and is designed to meet specifications MIL-E-5272A, MIL-E-5400A, etc. Environmental requirements include −65 to +200°F. and up to 60,000 ft. altitude.

Developed originally for motor start and run purposes, Airborne miniaturized "Mylar" capacitors are currently finding increasing application in electronic circuits where small size, light weight, and high reliability are of paramount importance.

Typical of such applications is one of our *own* servo control amplifiers, shown above. Used as a component of an Airborne-designed oil temperature control system for high performance aircraft, the amplifier consists of a .1% precision resistance bridge, stable feedback transistor amplifier, reference oscillator, phase demodulator, and relay output amplifier. Production units employ printed circuitry.

Two of Airborne's miniaturized "Mylar" capacitors are utilized in this particular amplifier — a .1 mfd unit for tuning in the reference oscillator section of the amplifier and a .02 mfd unit for phase shift correction in the stable feedback transistor amplifier section. Capacitors are epoxy encased and are designed to meet or exceed Government specification MIL-C-25A.

Wound of thin metallized "Mylar" film, Airborne miniaturized capacitors are rated up to 600 v d-c, 330 v a-c and have an operating temperature range of −75 to +300°F. At 300°F they will withstand 120% rated voltage for 250 hr.

Write, phone or wire for more information on Airborne special design miniaturized "Mylar" capacitors. Inquiries are also invited on complete electromechanical control systems.

*Du Pont's trademark for its polyester film

TYPICAL SPECIAL CAPACITORS

E-8109 Style E-8104 Style E-8107 Style

CATALOG 57B

Gives detailed information on Airborne special design miniaturized "Mylar" capacitors and Airborne R.F. filters. Write for copy.

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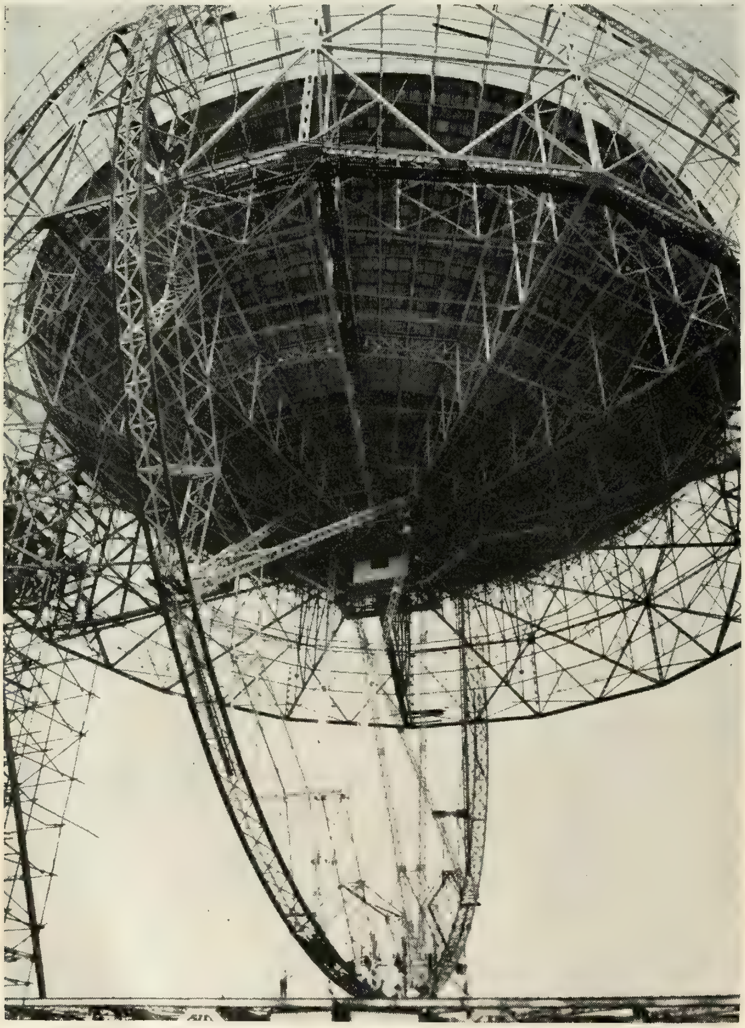
nique in miniaturizing circuitry. In addition to the award, Certificates of Excellence in miniaturization were presented to ten organizations and individuals for their outstanding contributions.

Machine Tool Conference Covers Industry Progress

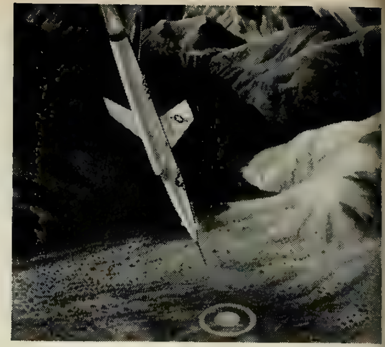
The 10th National Machine Tool Conference, sponsored by the American Institute of Electrical Engineers, will be held at the Statler Hilton Hotel in Hartford, Conn. on Oct. 13-15, 1958.

This year's program presents a balanced coverage of the industry's progress in the fields of tooling, gaging, machine control, computers, safety, precision positioning and machine design. Presentations will be made by leading engineers in the industry discussing operating experience with modern machine tool equipment.

In addition, papers on transistors versus tubes and computer fundamentals have been included, in recog-



GIANT RADIO TELESCOPE in Jodrell Bank near Manchester, England, is used to provide the initial tracking lock-on for the moon probe, and is ten times larger than any other of its type. Automatically steerable, it weighs 2,000 tons and revolves on bogies laid in a circle with a diameter of 360 feet. The telescope has the capability of reaching out into space one billion light years. Scientists at Jodrell Bank have already been able to detect radio waves emanating from the nebula in Andromeda, five trillion miles from earth. Pictured is a view underneath the radio telescope showing the stabilizing wheel, the motor house on the diametral girder and, underneath, the hanging laboratory which pivots on trunnions as the bowl rotates.



KEY ENGINEERING OPENINGS AT VOUGHT

AERODYNAMICS

Some of Vought's most vital and interesting problems are in general aerodynamics and automatic flight controls for supersonic and hypersonic weapons. This work involves trajectory and configuration analyses, autopilot studies, control system synthesis and other responsible investigations. Helpful in a number of areas are Vought's low- and high-speed wind tunnels with a speed range from Mach .05 to 5.0.

A limited number of additional specialists may find assignments to match their skills in Vought's aerodynamics activities. These men may have general aerodynamics experience, or a good background in automatic flight control systems.

Current Vought projects include:
DYNA SOAR
REGULUS MISSILES
SPACECRAFT STUDIES
F8U CRUSADER SERIES
NUCLEAR SYSTEMS STUDIES

Autopilot Engineer. A.E., E.E., or M.E., (M.S. desirable) plus at least 3 years experience in stabilization, or autopilot and servomechanism analysis and design. To assist in, or direct, autopilot studies and designs for supersonic airplanes and missiles.

Aerodynamics Engineer. Aerodynamics Engineer with A.E., or equivalent, and at least 3 years experience. To work on supersonic aircraft and missiles in aerodynamic analyses of performance, air loads, stability and control, or fluid mechanics.

To arrange for a personal interview, or for a prompt report on these or other current openings, return coupon to:

C. A. Besio
Supervisor, Engineering Personnel
CHANCE VOUGHT AIRCRAFT, Dept. P-5
Dallas, Texas

I am a __________ Engineer,
interested in the opening for __________
Name __________
Address __________
City __________ State __________

Vought Vocabulary

ac′cu·ra·cy: *guided all the way, this long-range missile pinpoints distant, hard-to-hit targets*

This nuclear-armed "bird" is the supersonic missile with which the U.S. can retaliate against the toughest of enemy targets – distant, hard-to-hit military fortifications.

Chance Vought's *Regulus II* provides the extra margin of accuracy that enables the Navy to zero in on such "small" – and deadly – strongholds as H-bomb storehouses, submarine pens, ballistic missile bases.

The instant *Regulus II* launches, its advanced guidance system takes control . . . constantly compensating, correcting . . . keeping this Mach 2 missile on target to the instant of impact.

In production now, *Regulus II* provides double deterrence: the power to help forestall nuclear war – pinpoint accuracy to deter localized trouble.

Scientists and engineers: pioneer with Vought in new missile, manned aircraft, and electronics programs. For details on select openings write to: C. A. Besio, Supervisor, Engineering Personnel, Dept. P-5.

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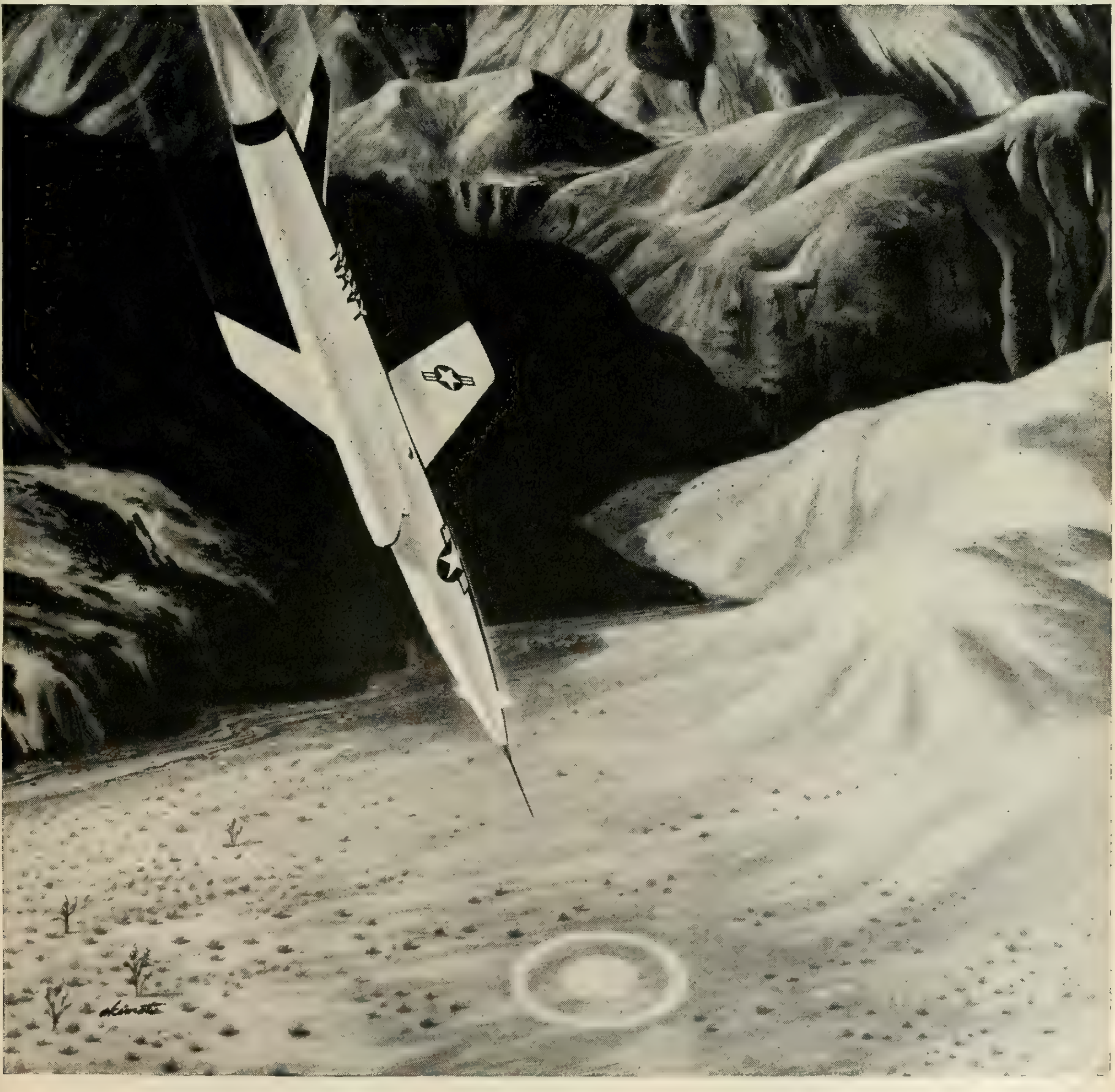

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Advanced missile and
space projects
require **Engineers** *and*
Scientists *to work on*

THE FRONTIERS OF SPACE

Lockheed Missile Systems Division, recently honored at the first National Missile Industry Conference as "the organization that contributed most in the past year to the development of the art of missiles and astronautics." holds such important, long-term projects as: the Navy Polaris IRBM, Earth Satellite, Army Kingfisher target missile, and the Air Force X-7 ramjet test vehicle.

To carry out such complex projects, the frontiers of technology in all areas must be expanded. Responsible positions in our research and development laboratories and in our project organizations are available now for high-level engineers and scientists.

If you are experienced in physics, mathematics, chemistry or one of the engineering sciences, your inquiry is invited. Please write Research and Development Staff, Sunnyvale 7, California. (For the convenience of those living in the East and Midwest, offices are maintained at Suite 745, 405 Lexington Ave., New York 17, and at Suite 300, 840 N. Michigan Ave., Chicago 11.)

FLIGHT IN THREE MEDIUMS

Several things set the Polaris apart from other outer space weapons in the ballistic missile category, for the Polaris program involves a wholly new concept of weaponry:

1. It will be dispatched from beneath the surface of the sea.
2. It will be radically smaller than currently developed land-launched missiles, yet its payload will be as effective and its range the same as other IRBMs.
3. It will be the first operational outer space missile to employ solid fuel as a propellant.
4. It will travel through three mediums in a single flight: water, air, outer space.
5. Its launching base—a submarine—is not fixed but a mobile vehicle.

OUTER SPACE PROGRAM

Very little can be said about the Earth Satellite program at this time except that its success will necessitate advancing the state of the art in all sciences.

The Earth Satellite Project is perhaps the most sophisticated outer space program to reach the "hardware" stage in the U.S. today.

TECHNOLOGY

ENEMY SIMULATOR

The Kingfisher is the nation's fastest target missile, developed for the Air Force and currently being manufactured for the Army to test the accuracy of our newest supersonic weapons.

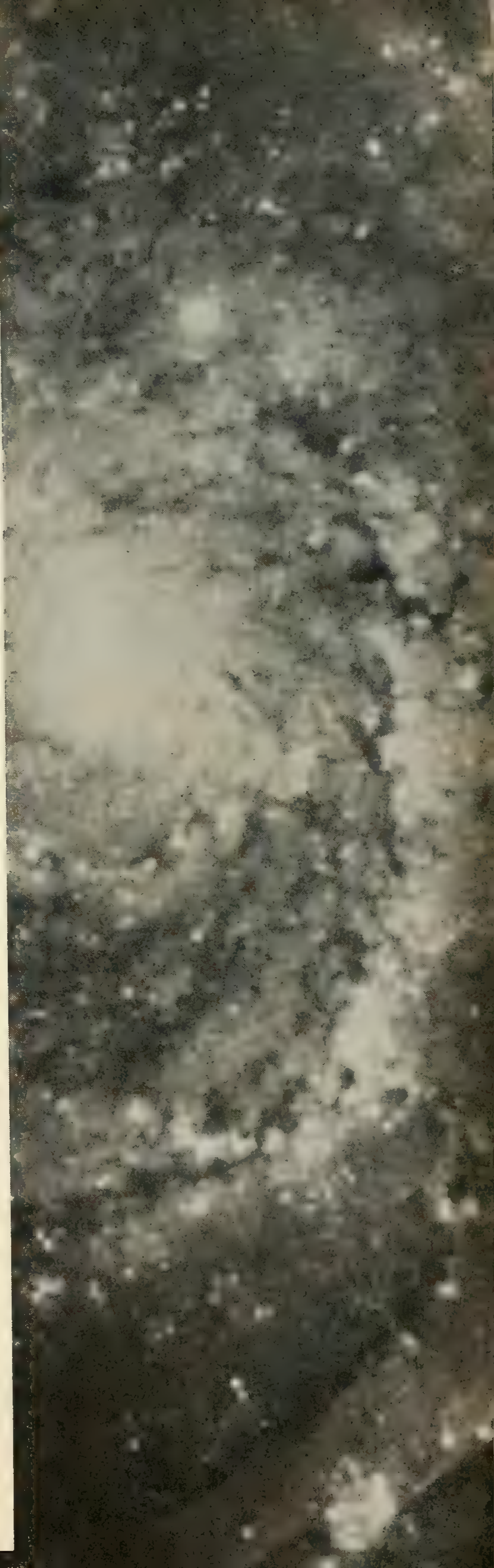
It is a ramjet target vehicle with Mach 2-plus capabilities. The Kingfisher not only has the speed to match the defensive missiles, but can also simulate a vast array of supersonic enemy missiles and airplanes attacking from great height. It is instrumented to score near misses and even theoretical hits without itself being destroyed.

It is recoverable from flight by parachute to be flown again, permitting weapon system evaluation to be conducted at greatly reduced cost.

Lockheed

MISSILE SYSTEMS DIVISION

SUNNYVALE • PALO ALTO • VAN NUYS • SANTA CRUZ
COOKE AIR FORCE BASE, CALIFORNIA
CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO



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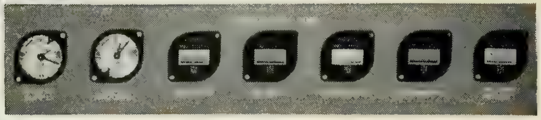
. . . So Use the A. W. HAYDON company's

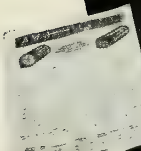
SUB-MINIATURE HERMETIC ELAPSED TIME INDICATORS.

You, too, can afford the space to keep track of time! From now on, these really small (1¼") Elapsed Time Indicators will keep company with the best of Electronic Miracles.



The illustration shows how the operating time of various sections of an electronic console can be monitored.

The dial type units read up to 2,500 hours in one hour increments, while the digital type units read up to 9999.9 hours in one-tenth hour increments. Designed for military applications, these 4½ ounce units can save valuable panel space in industrial and electronic applications.



The 400 cycle models now in production are described in Bulletin AWH ET 602.

The A. W. HAYDON COMPANY
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WATERBURY 20, CONNECTICUT
Design and Manufacture of Electro-Mechanical Timing Devices

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Model 8933
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EMERGENCY EYE and FACE WASH FOUNTAINS

Eye and face hazards are inevitable in industry . . . so take positive steps to reduce the extent of injury and minimize insurance claims. HAWS Emergency Eye and Face Wash Fountains flood contaminated areas with water — instantly ridding face and eyes of caustics, chemicals and dangerous particles. This **instant relief** may well prevent permanent damage — bridging the gap until medical aid arrives. Install extra safety — HAWS Emergency Fountains and Drench Showers.

Write today for detailed information on the complete HAWS line of emergency facilities. HAWS DRINKING FAUCET COMPANY, 1443 Fourth Street, Berkeley 10, Calif.

HAWS

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nition of the importance of these components to machine control. Another innovation appears in a series of five-minute talks on some of the less complex, yet interesting, new electrical products.

Other subjects to be included are "The Controlled Rectifier and It's Application", "Tooling for Guided Missiles & Rockets", "Operating Experience with Relays and Limit Switches", "Photoelectric Line Follower" and "Designing Machines for Servo Drives".

Plant tours through several major Connecticut industries, such as Pratt & Whitney Aircraft Jet Engine Facilities, have also been arranged.

Abraham A. Ribicoff, Governor of the state of Connecticut, will address the conference at a luncheon meeting. Attendance of over 1,000 is expected.

Conference To Discuss Interference Problems

Growing problems of electromagnetic interference with the proper functioning of military electronic equipment will be discussed at an Army-sponsored conference at the Museum of Science and Industry, Chicago, on Oct. 1 and 2.

The meeting, the fourth conference on Radio Interference Reduction and Electronic Compatibility, will be conducted by Armour Research Foundation of Illinois Institute of Technology, under agreement with the Signal Research and Development Laboratories at Ft. Monmouth, N.J.

The Institute of Radio Engineers Professional Group on Radio Frequency Interference will cooperate in the program.

Several papers to be presented will deal with the utilization of computer techniques in relation to large scale interference problems. These will include discussions of predicting the amount of interference existing among various parts of a system, how much interference will be created by the components, and maximum utilization of available frequencies to reduce interference.

Other papers will be devoted to instrumentation for obtaining objective measurements of the strength of interference, and methods of suppressing interference in equipment.

Discussions of mutual interference between radar installations will include the effect of assigning separate frequencies, equipment spacing, the effect of using modulation of varying characteristics, and operational techniques as a means of diminishing radio interference.

Approximately 450 persons repre-

high reliability . . . extreme compactness . . .

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NEW SANBORN 850

6- & 8-CHANNEL DIRECT WRITING SYSTEM

you want a practical direct writing system for straight- rward recording in the range from DC to 100 cps — such as omputer readout, telemetry recording — look what the new anborn "850" offers in compactness, reliability and operating onvenience. A complete 8-preamplifier module with power upply, plus an 8-channel flush-front recorder package con- aining power amplifiers and power supply at rear, occupy nly 24½" of "850" panel space.

ERFORMANCE characteristics of an "850" include flat requency response 0–70 cps, down 3 db at 100 cps (10 div. eak-to-peak amplitude) . . . thermal drift eliminated by urrent feedback power amplifiers . . . limiting at input to revent amplifier saturation or cut off, so that damping is ever lost . . . drift less than 0.2 div. for 20° to 40° C. changes, ine voltage changes from 103 to 127 volts . . . gain stability etter than 1% with 20° C. and 20 volt changes . . . linearity .2 div. over 50 divisions . . . clear, permanent, inkless record- ngs in true rectangular coordinates.

IN RELIABILITY, "850" features include fully transistorized power amplifiers and power supply . . . rugged galvanometers with low impedance, high current, enclosed coil assemblies and velocity feedback damping . . . JAN components wherever practical, such as MIL-T-27 hermetically sealed power transformers, MIL-approved electrolytics in power supplies, etc. . . . forced filtered air cooling for stable operation.

And in operating **CONVENIENCE,** an "850" system provides such advantages as nine electrically controlled chart speeds, selected by pushbuttons . . . a choice of interchangeable Preamplifiers (DC Coupling and Phase Sensitive Demodulator presently available, with others in development) . . . remote control of chart drive, speeds, timer and marker . . . monitoring connection points . . . a Recorder that loads from front and has built-in paper take-up and paper footage indicator.

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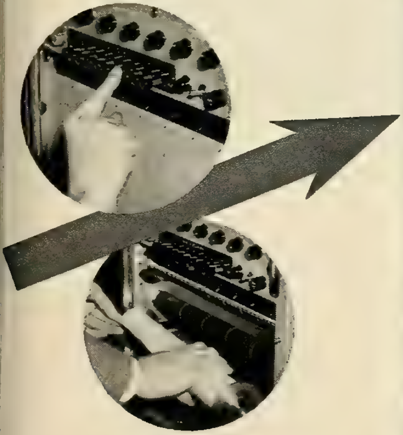

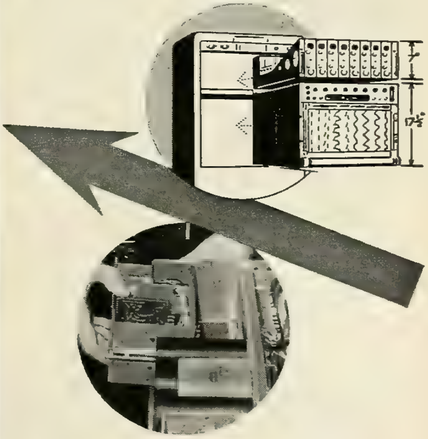

Ask your local Sanborn Industrial Sales-Engineering Representative for complete facts — or write the Industrial Division in Waltham.

(All data subject to change without notice)

Visit Sanborn Booths 957-959 at I.S.A. Show

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World's Most Rugged
PRESSURE TRANSMITTER

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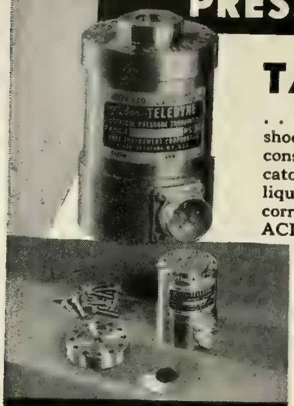
. . . is relatively insensitive to vibration or shock because of its bonded strain gauge construction. Use with standard servo indicators, recorders and controllers to measure liquid or gas pressures. Handles extremely corrosive media, including fuming NITRIC ACID. ● Linearity 0.25% ● Hysteresis 0.5% ● Ambient temp. —65° to +250° F (18° to 121°C) ● Pressure Ranges: 0 - 300 to 0 - 10,000 (PSIG).



Easily disassembled for clean out and parts replacement.

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Want big service in a tiny space? Our 207S is the answer. 400 G's at 2000 cps., 40 db open loop gain and 20 db closed loop gain ± 0.5 db, — 60° to + 160° C, stainless steel case.

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Cockeysville, Maryland

AAINC. MODEL 2830
MISS-DISTANCE MEASURING SYSTEM
AN/USQ-11

– developed by Naval Ordnance Laboratory, Silver Spring, Maryland
– product-engineered and produced by Aircraft Armaments, Inc.

OUTSTANDING FEATURES: Meets MIL-E-5272A 5400B, 16400 -- provides data in 2 min. -- requires transponder in drone only -- measures salvo firings -- determines miss on multiple targets. Target equipment (less power supply) under 2 lbs. Accuracy confirmed by field tests.

TARGET TRANSPONDER

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senting the Armed Forces, indust research, and education are expec to attend the conference.

Russian Satellite Book Gives Details of "Moons"

A new book—translated from t Russian and now available in the U —gives details on the laws of moti of artificial satellites, motion of t satellite relative to an observer earth, and other scientific discoveri

Published in translation by t Foreign Technical Information Cent Office of Technical Services, U.S. D partment of Commerce, the book authored by A. Shternfeld.

Of major interest are chapters co cerning observation of artificial sate lites, communications between the o jects and the earth. An appendix co cerns the dissemination of ideas astronautics, and the question of te ritorial rights in space above the earth atmosphere.

In chapters on construction an launching of satellites, Shternfeld di cusses the principles of the rocket e gine, powder and liquid rockets, desig of the engine, energy necessary to plac the satellite in orbit, influence of th earth's rotation, and similar problems

The book was first published b the State Publishing House of Technical-Theoretical Literature, Moscow in 1958. In English, it makes a 433 page volume.

Magnesium Enclosures House ARMA Guidance

Three magnesium enclosures—designed to eliminate dead weight and cut missile fuel requirements—house the ARMA ICBM inertial guidance system, it was disclosed last week.

Two of the enclosures—a three-deck computer section and a control-central case—are fabricated entirely from magnesium extrusions. The third enclosure—that easing the inertial platform itself—contains two deep-drawn magnesium hemispheres.

According to ARMA—a division of the American-Bosch-Arma Corp. of Garden City, N.Y.—the low weight of the whole system is the result of several factors, including exceedingly small gyros and computers, and the use of lightweight materials like magnesium. Each pound of dead-weight saved cuts the ICBM's fuel requirements by many pounds, company spokesmen added.

Official U. S. Air Force photo

F YOU, TOO, ARE ON THE WAY UP AND ARE QUALIFIED FOR A SENIOR ENGINEER-NG OR TECHNICAL MANAGEMENT POSITION IN INERTIAL NAVIGATION, THERE IS NLIMITED GROWTH POTENTIAL FOR YOU AT ARMA. HERE'S WHY. HAVING DEVELOP-D THE ALL INERTIAL GUIDANCE SYSTEM FOR THE AIR FORCE TITAN ICBM, ARMA AS NOW BEEN SELECTED TO PROVIDE INERTIAL SYSTEMS FOR FUTURE ATLAS PERATIONAL UNITS.

IF YOU WANT TO BE "ON THE WAY UP" WITH THIS PROGRAM, WRITE TO ARMA .... PROFESSIONAL PERSONNEL, GARDEN CITY, N. Y. PROMPT, CONVENIENT, CONFIDENTIAL INTERVIEWS.

AMERICAN BOSCH ARMA CORPORATION 6318

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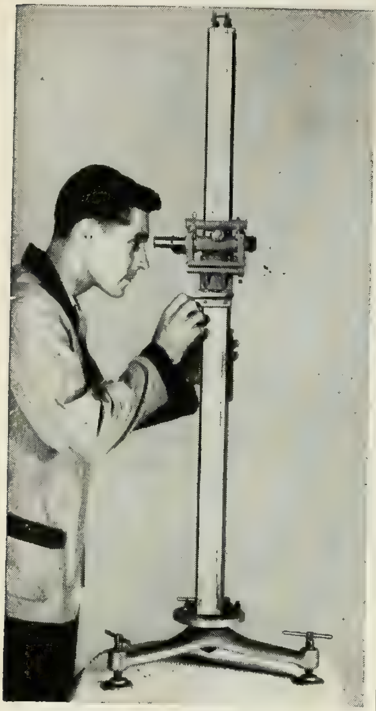
Optical instrumentation for
accurate measurement of
remote or inaccessible objects



Gaertner M901 General-purpose Cathetometer

CATHETOMETERS

Gaertner Cathetometers are designed for accurate measurement of vertical distances or displacements. They are ideally suited for measuring where the object or action is remote or not accessible by ordinary means. Gaertner produces a wide variety of precision-constructed cathetometers to meet your individual requirements.

- **General-purpose Cathetometers**—These combine a high degree of accuracy with a maximum of convenience. Range 100 cm, focusing range 60 cm to infinity.
- **Precision Cathetometers**—For maximum accuracy and rigidity. Readings directly to 1 micron.
- **Micrometer Slide Cathetometers**—For precise measurement of short vertical distances. Range up to 4" or 100 mm. With telemicroscope, focusing range 12 cm to infinity.
- **Co-ordinate Cathetometers** — Permit making precise co-ordinate measurements on objects in a vertical plane. Focusing range 9" to infinity. Co-ordinate measuring range up to 24"x42".

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Circle No. 51 on Subscriber Service Card.

soviet affairs

by Dr. Albert Parry

An "anti-meteorite shield" is an idea now being suggested by the Soviet engineer F. Yasinsky. "We are on the eve of space flight," he declares, "yet the problem of possible collisions with meteorites remains unsolved."

Data gleaned from the three *Sputniks* is now being evaluated in Moscow with regard to the impact of meteorites and micrometeorites on today's earth satellites and tomorrow's space ships. Yasinsky points out that defense against meteorites must be a fact before interplanetary travel becomes possible.

The Soviet engineer sees little likelihood of a collision with a big meteorite. A space ship could detect such a meteorite by radar and visual means, and so avoid it.

But it is another matter with "small meteorite bodies weighing from a gram's fraction to several tens of grams." Meeting such a body can be fatal for a satellite or a space ship, since "the thermal energy generated by such a clash equals an explosion of several tons of trotyl."

His "space umbrella," as Yasinsky occasionally calls his anti-meteorite shield, is proposed in the form of a disc, 20 to 50 meters in diameter. It will be made of steel in just one layer of one-half meter to two meters in thickness, and fastened to a frame.

The weight of the shield should be "not in excess of one per cent of the cosmic rockets of the future." In the "knots" of the frame, Yasinsky would put several small rocket motors, small containers with fuel ("several tens of kilograms"), and special telemechanical equipment.

The shield will be towed by the ship. However, the moment the space ship reaches its predetermined speed, and the pilot turns off the motor, changing to flight by inertia, the shield will be uncoupled and sent on its "free flight."

The ship's pilot, guiding the shield's motors by radio, will place the shield parallel to the ship, at a distance of "several tens of meters." Continuing on its parallel course with the ship, the shield will then protect the space ship from meteorites.

The thickness of the shield's wall will be calculated in a way to allow its inevitable piercing by meteorites of a dangerous kind. At the blow, the tremendous kinetic energy will become thermal energy. This will result in an enormous heating of the meteorite, along with similar heating of a part of metal torn out of the shield by the meteorite.

Instead of the meteorite, a lump of gas will now fly toward the space ship—a red-hot lump, broadening at a terrific speed, its temperature in millions of degrees.

But en route to the ship, due to the distance between it and the shield, this lump will have time to widen considerably, to cool off, and in part to disperse. Thus the space ship will collide not with the meteorite, but with the far less harmful "porous" gas cloud.

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Measuring the bore of a steel liner ground in assembly with the lower housing of the Sikorsky S-56 Helicopter transmission. Its complex, thin-walled casting must be machined with all bores and faces within an angular tolerance of plus nothing and minus one minute and thirty seconds and with linear tolerances of plus or minus .002.

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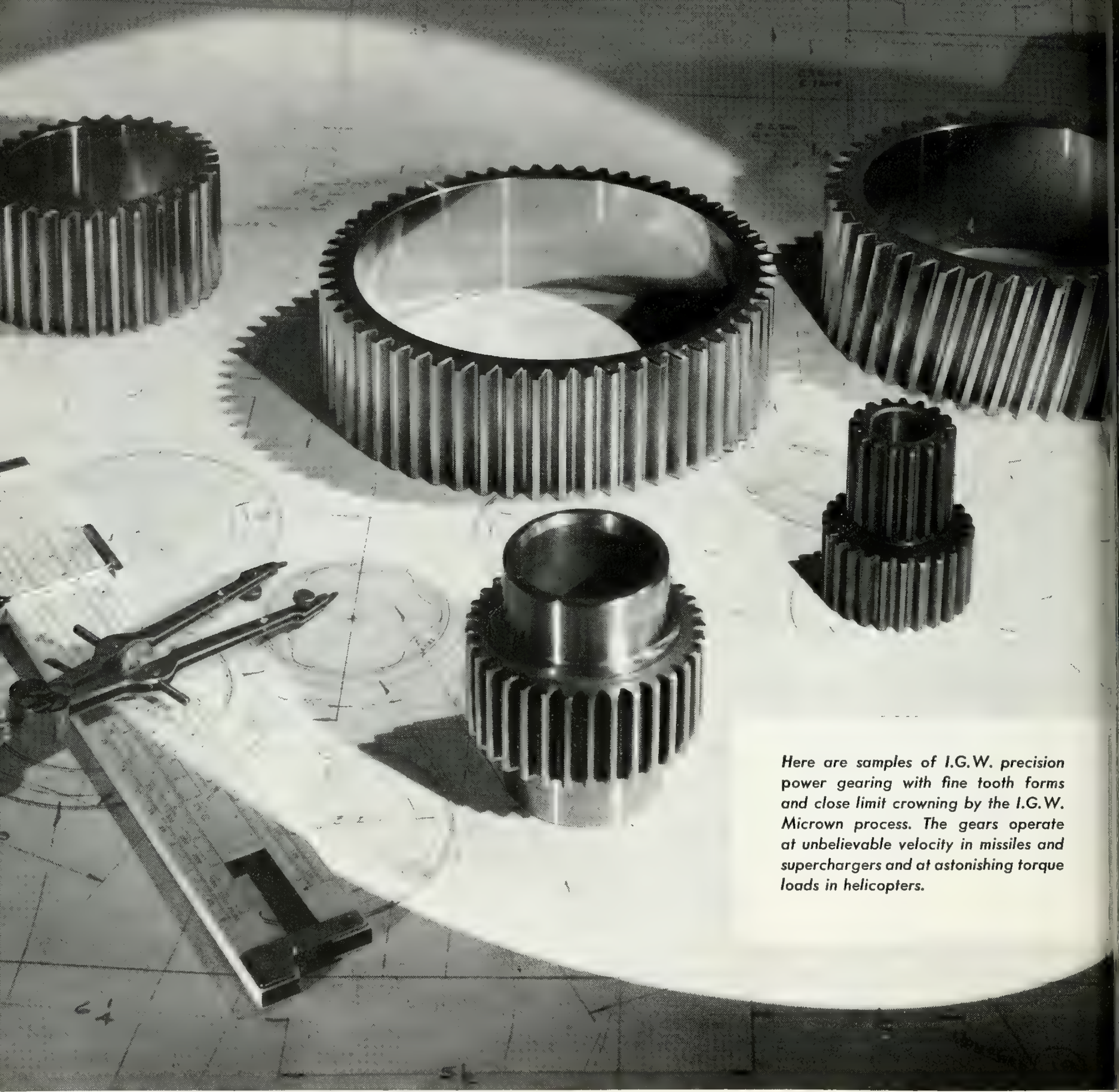

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moscow briefs

Soviet-imposed anonymity is the only discomfort or offense that Russia's experts in rockets and missiles may now feel—but this is a slight discomfort compared with the ample salaries, fine country villas, and other plush emoluments which Khrushchev gives his scientists in return for the ICBMs, IRBMs, *Sputniks* and possible flights to the Moon. So said Khrushchev himself in a speech delivered while visiting a chemical factory in East Germany.

And the only reason he does not publicize the identities of Soviet rocket and missile men is to protect them and Russia's scientific and military secrets "from enemy agents who can be sent to destroy such outstanding people who are our treasured personnel." Yet, in time, the names and photos of Red rocket and missile makers will be published, the Soviet chief promised. He did not, however, set the approximate time of such publication.

A Red Chinese *Sputnik* is a thing of the near future—the Red government of Peking is "determined to get China's artificial earth satellite into the sky at an early date." This comes from Kuo Mo-jo, president of the Red Chinese Academy of Sciences. The Soviet government of Moscow is expected to help, but not too enthusiastically. Mao Tse-tung is pressuring Khrushchev for a space-age arsenal and, generally, for a greater voice in the space era's international politics. Khrushchev, reluctantly, has given it.

On the recent occasion when Khrushchev and his Marshal, Rodion Y. Malinovsky, visited Mao and his generals in Peking, the Russians had to yield to Mao's insistence on more industrial and military assistance. Military assistance, it is reported, includes Soviet missiles and anti-missiles to be installed for the Chinese Communist forces on China's mainland opposite Formosa. It will be the Red answer to the American ballistic missile pads placed on Taiwan for the Chinese Nationalists.

Red Chinese astronomers will be allowed to come to the United States in 1961 to attend the General Assembly of the International Astronomical Union, of which Communist China is a member. This ruling was made by the State Department, and it also covers other countries with which the United States has no diplomatic relations. A reservation is made, however, stipulating that Chinese delegates and others will not be allowed to lecture in our universities while in this country.

The United States Attorney General, by law, has to make the final decision in this matter, but he is expected to abide by the State Department move. Our leniency is thought to have good propaganda value as a contrast to the failure of the Soviets to permit Chinese Nationalist scientists from Taiwan to come to Moscow for the recent Fifth Assembly of the governing body of the IGY.

Solid benzine as a wonder-working fuel is drawing the attention of Soviet scientists. The Moscow Institute of Fuels, Minerals and Ores is checking the results of experiments with solid benzine at the Soviet stations in Antarctica. The role of Soviet-made solid benzine is of special interest in extremely low temperatures—(noted by the Russians near the South Magnetic Pole as minus 84.3 degrees C or minus 119.74 degrees F at their lowest). These experiments were also made under the conditions of lack of oxygen.

One aspect of such Soviet experiments and experience is, however, not made public. This is the Soviet use of solid benzine in rocketry. However, in KRASNAYA ZVEZDA, a brief reference is made to the employment of solid benzine "in motors."

It is explained that solid benzine comes in briquets of white or yellowish color, and that the "cell-walls" of such briquets "possess great solidity and elasticity," being made of "polyvinyl alcohol which is a high-molecular compound." To feed solid benzine into the motor's fuel containers, it is necessary to break the briquet "cell-walls" by compressing the briquets, the Soviet Army newspaper adds.

Seaweed as space-crewmen's food is discussed by Lieut Col. I. Krestovsky in SOVETSKAYA AVIATSIA. In his article, "The Cosmic Breakfast," he states that the Institute of Physiology of the Soviet Ukrainian Academy of Sciences is carrying out experiments with the algae (seaweed) called chorella. This contains "a high ratio of organic matter and mushrooms."

These chorella plants will not only feed the crew but, by being installed inside the space ship, they will restore the micro-atmosphere of the ship. "A mass of chorella weighing 2.3 kilograms can produce, within one hour, 25 liters of oxygen," the article states. In the meantime, these plants will themselves thrive on the carbon dioxide exhaled by the space-ship's crewmen.

Weightlessness is not a handicap in space flight, declares Dr. V. N. Chernigovsky, a member of the Soviet

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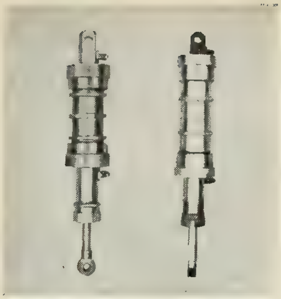

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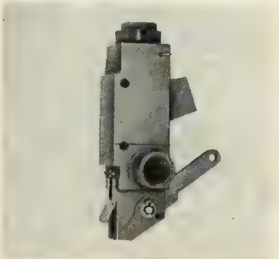

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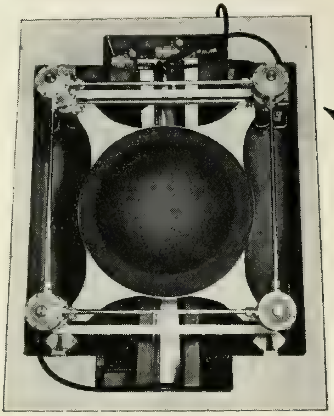
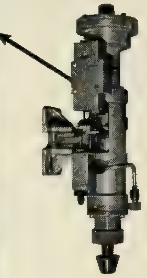


Vibration Isolation System



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The system shown above is one of several Kidde pneumatic vibration isolation system programs for protecting delicate missile control systems from undesirable vibratory disturbances and great transients in "g" loading which would affect accuracy of control. The component in the inset photo incorporates the system's mechanical and air snubbers, air spring, servo valve and passive isolator.

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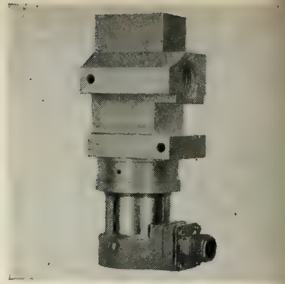

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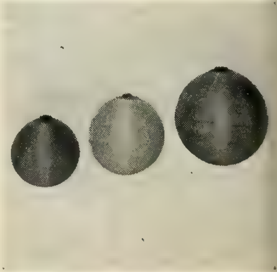

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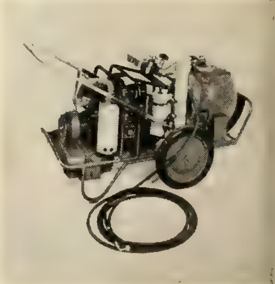

PORTABLE GROUND SERVICE CART: 4cfm compressor, drive unit, air driers and pneumatic storage sphere. Provide service at either 3000 or 5000 psi.

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Academy of Medical Sciences and a corresponding member of the main Soviet Academy of Sciences.

In KOMSOMOLSKAYA PRAVDA, he states that, "data at our disposal does not conclude that weightlessness is a condition preventing man's flight into interplanetary space." Dr. Chernigovsky speaks of the value of Laika's journey as adding to man's knowledge of weightlessness. He hints of inclusion of other dogs, as well as other animals, into Soviet *Sputniks* that will be orbited in the future.

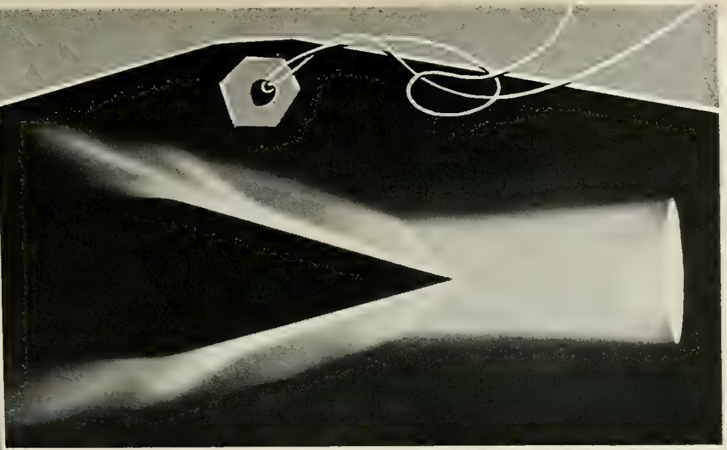
In describing the "Physicists' Town" and its special cosmic radiation observatory and laboratory established in the high Pamirs (Central Asia) by the Physics Institute of the Soviet Academy of Sciences, a correspondent of IZVESTIA declares that the "rain" of cosmic rays in these mountains is "ten times more intensive than, say, near Moscow." He also stated that "nuclear explosions of individual atoms of air caused by cosmic rays occur 15 times more frequent in the mountains than at sea level."

Important results have been achieved in the research carried out in the Soviet Pamir observatory and laboratory by Academician D. V. Skobeltsyn, Professor N. A. Dobrotin, and G. T. Zatsepin. These men earned Stalin Prizes for their Pamir cosmic ray work. Professor Dobrotin is in charge of the Pamir group of physicists and astrophysicists.

One million operations per second—this is the aim of Soviet designers for future electronic computers, according to V. Alexandrov, chief of the Designing Bureau of the State Planning Committee of the Soviet Union. Writing in PRAVDA, he urges a much wider utilization, in Soviet computers, of semiconductors made of germanium and silicon, "instead of electronic lamps."

From 2,000 to 30,000 operations per second is the present capacity of Soviet computers, it is revealed in an article by V. Belkin, a staff member of the Soviet Academy of Sciences Laboratory of Computing Machines and Systems.

The *Sidewinder* will be manufactured in Holland, declares KRASNAYA ZVEZDA, quoting the Dutch press. The Soviet Army newspaper comments that "last fall the United States promised to place in Holland its military contracts after the Dutch government had agreed to the installation of American rocket bases in that country." Sharp disap-



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Gas Flow Rate (lb/sec)	.003	.0058	.0177
STAGNATION ENTHALPY			
ht (btu/lb)	11,200.0	5100.0	1600.0
Stagnation Pressure (psia)	5.74	7.61	7.14
Stagnation Temperature (°K) (equilibrium air)	6650.0	5350.0	2815.0
Nozzle Pressure Ratio	15.0	15.0	15.0
FREESTREAM ENTHALPY			
h(btu/lb)	8130.0	3325.0	880.0
Freestream Pressure (psia)	.382	.508	.475
Freestream Temperature (°K)	5450.0	3560.0	1298.0
Freestream Velocity (ft/sec)	12,390.0	9430.0	6000.0
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. . . moscow briefs

proval of the "imperialistic" deal is indicated by the Red article.

Unfriendly ***Sputniks*** will have to be chased, stopped, and thrown out of their orbits. So OGONIOK quotes General John B. Medaris. The Moscow journal angrily adds, however, that "thus far the warlike zeal of the American general has weak grounds in reality." For, says OGONIOK, there is no such thing as an unfriendly *Sputnik*.

It goes on to ask, "Why is it that while the whole world rejoices with each success in man's conquest of cosmic space, some people in the United States so stubbornly strive to make a war arena out of Cosmos?"

You can shoot from the Moon to the Earth more easily than the other way around. This statement comes from Professor F. Rybkin, writing in KRASNAYA ZVEZDA. He quotes Konstantin Tsiolkovsky, the great Russian pioneer of rocketry, to the effect that "at least a four-stage rocket is needed to fly from the Earth to the Moon." He then goes on to say that a single-stage rocket is enough for the flight from the Moon to the Earth.

"In other words," the Moscow professor continues, "in order to shoot from the Moon to the Earth, it is sufficient to possess rockets of a shorter range rather than intercontinental ballistic missiles." This means, he deduces, that "the Moon represents a position dominating over the Earth."

Professor Rybkin proposes international control for man's doings vis-a-vis the Moon and the nearby asteroids—control "which will exclude the possibility of their use by the reactionary forces of capitalism for aggressive purposes."

Making fun of the recent American concern to prevent radioactive substances from reaching and contaminating the Moon in man's attempts to send rockets there, KROKODIL suggests that soon the U.S. will offer resolutions "in favor of liquidating military bases on Mars . . . advocating non-interference in the domestic affairs of the planet Neptune . . . proposing a non-aggression pact with the star Sirius . . . also proposing a disarmament agreement within the limits of the Milky Way."

Wouldn't it be more fitting for Americans, the satirical Moscow mouthpiece inquires piously, to stick to earthly affairs by "following the Soviet example in suspending atomic tests?"

Cosmic radiation, as recorded by

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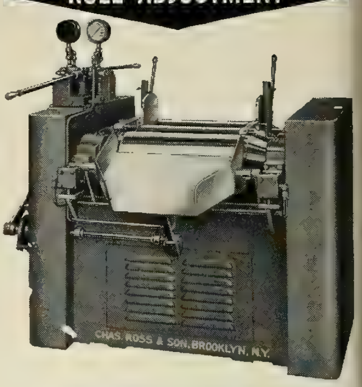

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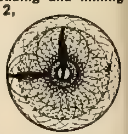

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artificial earth satellites, was discussed in Moscow at the recent Fifth Assembly of the IGY governing body by Professor Sergei N. Vernov, a corresponding member of the Soviet Academy of Sciences. American and other Western scientists present at the lecture found it of great interest, although it did not answer all they wanted to know about the *Sputnik*-gathered store of knowledge.

Dr. Vernov pointed out that the Soviet study of cosmic radiation was begun in 1947 with the aid of rockets. In 1951, Russian scientists measured the ionization caused by cosmic rays up to the heights of 100 kilometers. The figures from this rocket-study of ionization were in part used by Moscow's savants in preparing and analyzing the flights of *Sputniks* II and III.

As a result, it is now possible to make a chart of the distribution of cosmic rays around the Earth and thus investigate the Earth's magnetic field. Special equipment was installed in *Sputnik* II to measure radiation produced data, the analysis of which permitted the spotting of considerable increase in the intensity of radiation.

On November 7, 1957, from 4:46 to 4:49 PM Moscow time, in latitudes above the 58th degree, this intensity rose approximately 50%. The *Sputniks* register a new kind of radiation, which Dr. Vernov calls "the Earth's radiation"—as it originates near the Earth and moves around our planet.

Sputnik III measured ionization, the extent of which experienced strong changes. Surplus ionization, Dr. Vernov asserted, was caused by electrons of low energies. *Sputnik* III has a luminescent counter possessing a high sensitivity in registering photons.

American curiosity was not satisfied about certain aspects of *Sputnik* results at the Fifth Assembly of the IGY governing body in Moscow. American delegates were prepared to give practically every detail gleaned from the *Explorer* and *Vanguard* experience, but the Russians proved cagier.

True, the Russians reported on their oceanographic work in the optical tracking of their satellites, also on cosmic ray studies, and on certain special Soviet-devised instruments in the satellite field.

But they refused to divulge the size and weight of each object placed in orbit, particularly those of the final stage rockets. This data (the Americans pointed out) was needed in aiding density studies. The Soviets refused to say anything definite about the motor used in hoisting their *Sputniks*.

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world astronautics

by Frederick C. Durant III

An Astronomical Observatory in satellite orbit has been a fond dream of astronomers who struggle to peer through the murky turbulence of our atmospheric blanket. Prof. Fred. L. Whipple, Director of the Smithsonian Astrophysical Observatory (SAO), Cambridge, Mass., believes that a respectably sized satellite-telescope, equipped with television transmission, could be designed, developed and built in 18 to 24 months.

Together with associates at SAO and Harvard College Observatory, Whipple has made a study of the scientific and engineering aspects. Initial thinking indicates an 8-in. aperture off-axis mirror of 24-in. focal length. With a conventional TV recording surface, such a telescope would give a resolving power of the order of 20 seconds and a field of approximately 4 square degrees. To cover the entire sky, 10,000 direct images would have to be recorded.

This rate is about the same as the number of images produced in commercial television during six minutes of operation. Doubling the power requirements and operational life would allow a second survey of the sky with "objective grating" spectra, at little additional expense for design or structural changes.

Engineering problems to be faced include: stabilization of the telescope platform against rotation and control of its orientation in space; lightweight, rigid design; power sources; and the stresses of vibration and acceleration imposed during launching. So much of scientific value could be learned from a satellite telescope that we feel justification and funds will be found to place one in orbit by 1961.

Underwater jet propulsion tests were made at the Italian Navy Base at La Spezia in July. Both hydroramjet and hydrorocket propulsion techniques are being studied by Capt. Glauco Partel, who has several designs for such power plants. The July trials were confined to two successful 15 second runs of Partel's hydroramjet, A-80. Fuel used was lithium aluminum hydride. The fuel to be used in tests scheduled for September will be a mixture of sodium hydride in oil.

The Human Factors Division of the ARS has a Subcommittee on Instrumentation of Biological Parameters, headed by Lt. Col. Hessberg, USAF, of the Aero Medical Lab., Wright Aero. Dev. Center, Dayton. The Subcommittee has suggested two simple approaches for instrumentation of bacteria studies in biosatellites. One concept would use acid-forming bacteria, measuring changes in potential with a diode. The other would use pigment producing (fluorescent) bacteria with photoelectric measurement. Weight and volume requirements for instrumentation were estimated to be less than 3 oz. and 6 cu. in.

Rocket stations for hail defense—In an effort to reduce the destruction caused by hail storms, an extensive series of tests are planned in Bavaria at this time. Sixty rocket stations have been established in three rows along the Inn River and five more at Lake Sim.

Program is under the direction of the Munich-Riem Aerological Station of the German Weather Service on the basis of experience gained by the Swiss. A parallel program utilizing ground generators of silver iodide vapor from a propane gas flame will obtain comparative results of effectiveness and economy. An observers' organization with 267 members from state agricultural agencies has been created to warn of approaching storms.

A meteorite is small—everyone knows that. But, how large is a "falling star" that appears as bright as Venus as it streaks across the sky? Willy Ley says "about a half-inch in diameter and weighing about one seventh of an ounce."

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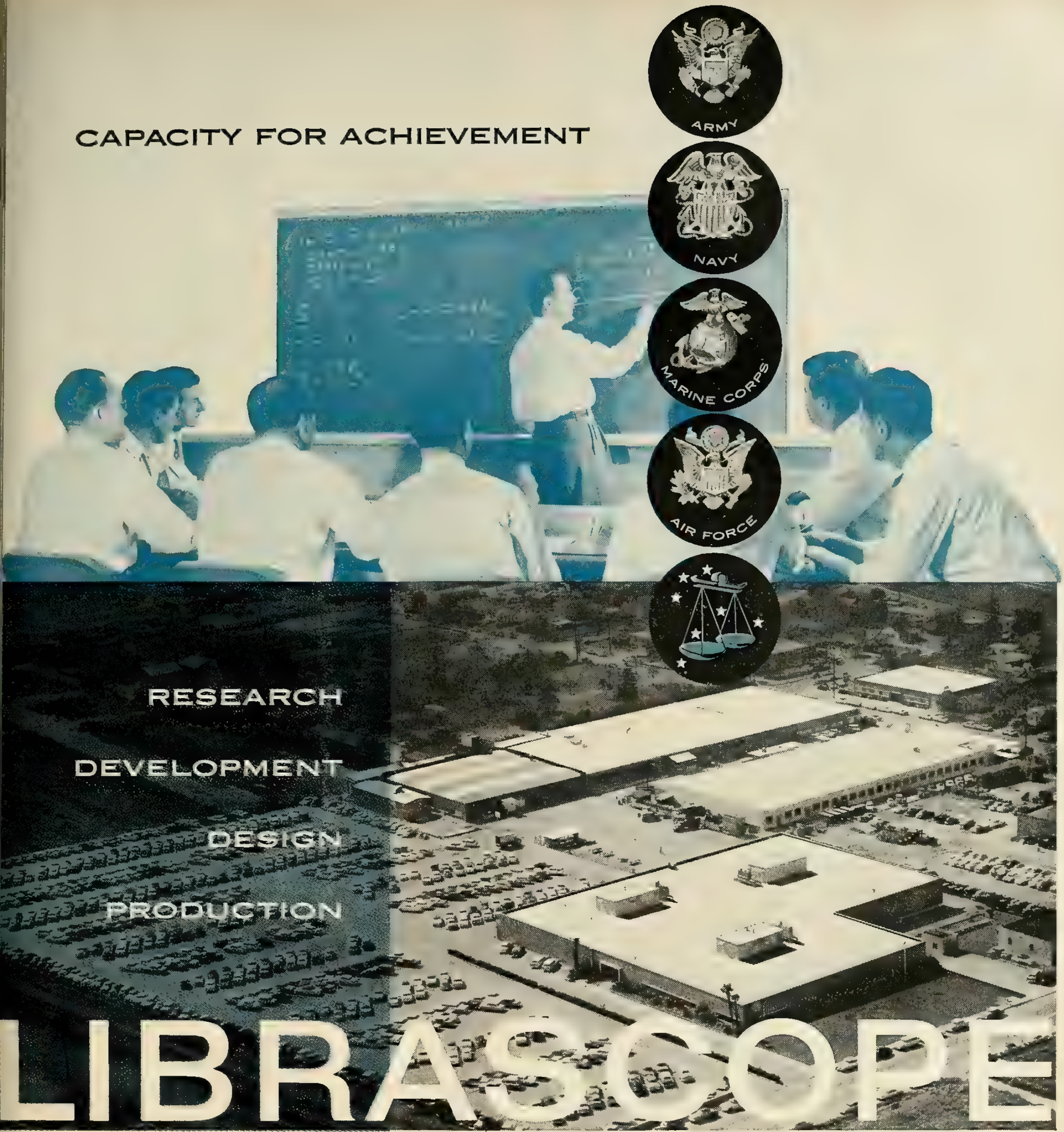

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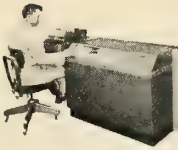

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high-energy fuel briefs from Callery

Callery, GM, Thiokol sign working agreement — The working agreement between these three firms is aimed at developing advanced devices in the field of guided missiles and space travel. Callery, General Motors and Thiokol have already done extensive pioneering in specific phases of missile and space development. Callery will provide the combination with propellant components for space vehicles. The new agreement does not restrict the participants from working with other companies in the same areas.

HiCal® high-energy fuel for the Navy — The first production quantities of HiCal-3 — were made at our new Lawrence, Kansas plant in August. Virtually all fuel from the Lawrence plant is earmarked now for the military. Quantities of HiCal may become available in the future however, for authorized users.

New Muskogee, Oklahoma plant on contract schedule — The Navy HiCal facility at Muskogee, Oklahoma is still under construction, and on contract schedule. First process units will start up in September.

New pyrophoric ramjet fuel: Triethylborane — TEB is spontaneously flammable in air, but does not react with water. Density at 25°C is 0.68. Melting point is −92.5°C. Boiling point is 95°C. Heat of combustion is 20,200 B.t.u./lb. It is miscible with hydrocarbons, so it can be used as an additive to conventional fuels.

TEB has much wider flammability limits than hydrocarbons. Thus TEB permits higher altitude flights and simpler engines. *For further data send for new Technical Bulletin CCC-310 and Handling Bulletin CCC-311.*

A suggested heat sink: Lithium Borohydride — $LiBH_4$ is a solid — melts at about 532°F with decomposition. Complete decomposition at 1800°F would absorb more than 6,000 B.t.u./lb. It is soluble in hydrazine and the solution may be a good rocket fuel. *Write for Technical Bulletin CCC-130 for more information.*

Phone: FOrest 4-1130
TWX: Perrysville, Pa. 117

Benjamin S. Yaffe
Technical Service Engineer
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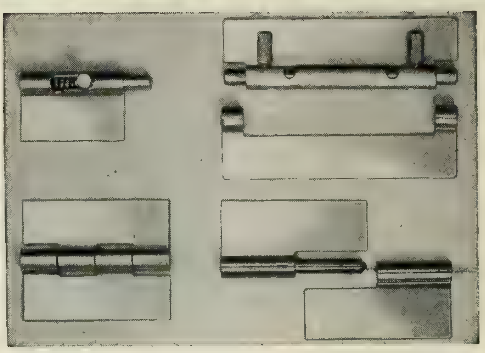

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space age

by Norman L. Baker

First powered flight date for the X-15 continues to be pushed further into the future. Latest reports see summer of '59 as a conservative estimate. Major bottleneck is still the 60 k engine under development by Reaction Motors Division of Thiokol. Reaction Motors is currently receiving assistance from Rocketdyne on the development of the first engine. The 54-60 k sustainer engine for the *Atlas,* for some undisclosed reason completely ignored during the initiation of the X-15 program, will, with modifications, be used as a back-up unit.

Army's ABMA is making great strides in the engine development program leading to the million-pound thrust engine system. Last week the Huntsville area was subjected to the blast of the first successful firing of the free world's largest single engine. Thrust was reported to be in excess of the 300 k thrust engine system under development by Rocketdyne (m/r, Aug. 11, p. 74). The solid propellant motor (reported thrust—450 k) has such a high acceleration level that it will be undesirable for manned space applications.

The second-stage of the *Thor-Able* I (Air Force's first *Pioneer* lunar probe) may have been recovered about 650 miles northeast of Cape Canaveral, although no DOD announcement has been made. Five days after the attempted launch on August 17, a destroyer from Task Group Alpha (200 miles off Cape Hatteras) picked-up a section of a missile approximately 12-feet long and weighing about 500 pounds. The missile section, nearly intact, contained propellant tanks and wiring.

The United States may have to revoke its present policy of not laying territorial claims in Antarctica, or do as the Russians are doing—start building permanent rocket launching bases at that location. According to Prof. S. Fred Singer (m/r, Sept. 1, p. 19), the high energy of the radiation belt discovered by the *Explorer* satellites may force origination of manned space flights from launching pads in the very high latitudes or in the polar regions. Singer advanced the theory that the belt is comprised of protons trapped in the magnetic lines of force of the earth with maximum thickness at the equator arcing in to a region of cleared radiation at the poles.

Fluorine, the near-ultimate in oxidizers for liquid rocket engines, has been combined successfully in large-scale rocket thrust chambers at Bell Aircraft. If fluorine's tremendous logistical problem can be satisfactorily eliminated (a factor that makes it undesirable for missile weapon systems), it should receive extensive use in future space operations. Combined with existing fuels it will be possible to increase the rocket engine's thrust as much as 40% with a payload increase of 70%.

Republic Aviation is in the early stages of development work on a "magnetic pinch plasma engine" for interplanetary travel. Research under way is expected to lead to an operating powerplant. Currently, random undulations in the boundary layer of the pinch is posing a major problem. Ions and negative particles will be compressed in a magnetic field and accelerated in a single exhaust stream. An ion accelerated powered interplanetary vehicle proposed by Boeing would use sun-vaporized cesium for fuel. Both systems have been suggested as power sources for unmanned Mars exploratory vehicles.

The success or failure of a lunar probe is dependent upon two major parameters—exact timing and precise power control. For example, to intercept an area on or in the region of the moon requires launching of the vehicle within a two minute interval with exact final velocity attainment at a prescribed altitude. At a cut-off velocity of 23,700 mph, the vehicle will not reach the moon. An additional 30 mph will send the rocket to an intercept in 4 days, a velocity of 23,860 would cut the flight time to 2½ days.

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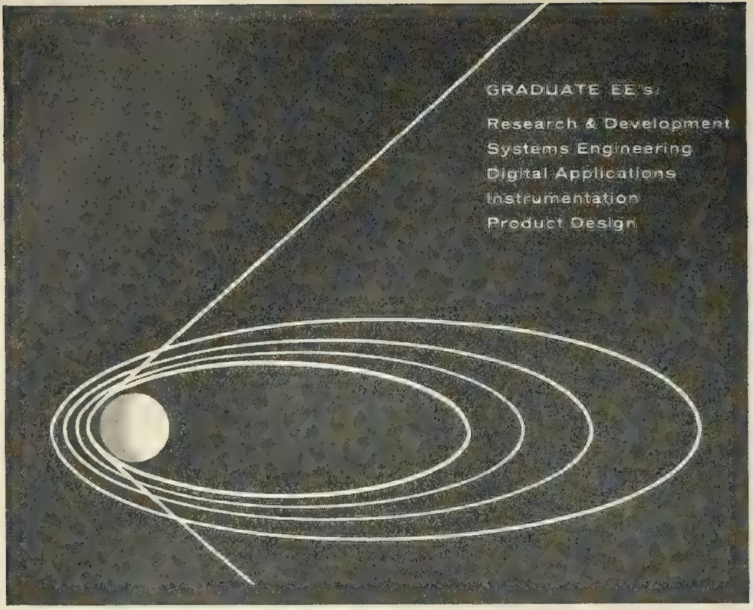

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letters

Ampex Shares Up

To the Editor:

Under "Industry Countdown," August 25, you report Ampex Corp. "dropped per share earnings to 90 cents for the 1958 period (fiscal year) ending April 30," compared to $1.51 per share in fiscal 1957.

Actually, net per share for our fiscal 1958 was a record $2.10, or 39% above the year-earlier figure. In every respect, fiscal 1958 was the best in Ampex's 12 year history.

William M. Cox
Instrumentation Advertising
Instrumentation Div.
Ampex Corp.
Redwood City, Calif.

This is certainly good news, and of course, should be made clear to m/r readers . . . Ed.

Million-lb. Red Engine?

To the Editor:

In regard to the current interest in developing million-pound thrust engines, an extract from the Russian press has recently come to my attention.

In the April 1958 issue of VESTNIK VOZDUSHNOVO FLOTA, an article appears entitled "Some Problems of Rocket Technology," written by a Major General Mel'kumov. On page 81, the author writes, "The thrust of a contemporary single liquid-fuel rocket engine reaches (a value of) 450 (metric) tons."

At 2,200 lb./m. ton, this comes to about one million lbs. Specific inclusion of the word "single" (edinichnovo) seems to rule out a ganged engine, and indications would seem to be that this motor was at least in the testing stage when the article was written.

Stanley Ross
Missile Systems Div.
Lockheed Aircraft Corp.
Sunnyvale, Calif.

Thank you! This certainly supports the opinion of many experts as to the nature of the lead the Russian missilemen have given their country over our own . . . Ed.

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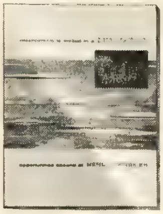

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W. C. Schoolfield,
Assistant Chief Engineer, Missile Technical Dept. P-10.

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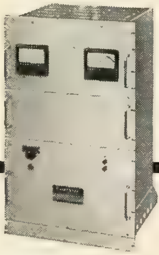

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advertiser's index

AMP Incorporated 54
Acme-Newport Steel Co., a Sub.-Acme-Steel Co. 6
Airborne Accessories Corp. 79
Aircraft Armaments, Inc. 86
Air Reduction Sales Co., Div. of Air Reduction Co., Inc. 71, 72
American Bosch Arma Corp. 87
American Brake Shoe Co. 4
Avco Mfg. Corp., Crosley Div. 65
Research & Advanced Development 8
Barco Manufacturing Co. 42
Beckman & Whitley, Inc. 58
Bendix Aviation Corp., Bendix Products Div. 95
Boeing Airplane Co. 44
Brush Instruments, Div. of Clevite Corp. 22
Buckeye Iron & Brass Works 63
Burklyn Co. 100
Callery Chemical Co. 100
Camco Fittings, Inc. 69
Canoga Corp. 78
Caterpillar Tractor Co. 52, 53
Chance Vought Aircraft, Inc. 80, 81
Christie Electric Corp 106
Consolidated Electrodynamics Corp. 73
Continental Aviation & Engineering Corp., Sub.-Continental Motor Corp. 68
Cox & Co., Inc. 66
Data-Control Systems, Inc. 91
I. de Calesta & Co. 106
Delco Radio Div., General Motors Corp. 59
Douglas Aircraft Co., Inc. 74
Electro Instruments, Inc. 108
Excelco Developments, Inc. 67
Gaertner Scientific Corp. 88
G. M. Giannini & Co., Inc. 45
Giannini Plasmadyne Corp. 93
Hallamore Electronics Co., a Div.-The Siegler Corp. 40
Hart Mfg. Co. 75
Haws Drinking Faucet Co. 84
A. W. Haydon Co., The 84
Hewitt-Robins Industrial Products 96
Hi-Shear Rivet Tool Co. 64
Humphrey, Inc. 39
Indiana Gear Works, Inc. 89, 90
International Business Machines Corp. 48
Kearfott Co., Inc. 56
Walter Kidde & Co. 92
Kollmorgen Optical Corp. 107
Laminated Shim Co., Inc. 36
Librascope, Inc. 99
Linde Co., Div. of Union Carbide Corp. 12
Lockheed Aircraft Corp., Missile Systems Div. 82, 83
Mallory-Sharon Titanium Corp. 35
Johns Manville Corp. 60
Jas. H. Matthews & Co., Inc. 98
Minneapolis-Honeywell Regulator Co. Mircro Switch Div. 76, 77
Normandy Electric Wire Corp. 19
Nitrogen Div., Allied Chemical Corp. 37
Non Linear Systems, Inc. 2
Pure Carbonic Co., Div. of Air Reduction Sales Co., Inc. 28
Pyro-Electric, Inc. 94
Radio Corp. of America 97
Raybestos-Manhattan, Inc. 55
Raytheon Mfg. Co. 20
Rochester Mfg. Co. 70
Charles Ross & Son Co., Inc. 94
Sanborn Co. 85
Snap-Tite, Inc. 41
Sperry Gyroscope Co., Div. of The Sperry Rand Corp. 10, 11
Statham Instruments, Inc. 62
P. A. Sturtevant Co. 18
System Development Corp. 43
Taber Instrument Corp. 86
Telecomputing Corp. 18
H. I. Thompson Fiber Glass Co. 57
Titanium Metals Corp. of America 26
United Aircraft Products, Inc. 21
Voi-Shan Mfg. Co. 3
Weatherhead Co., The, Aviation Div. 51

EMPLOYMENT SECTION

Bendix Aviation Corp., Bendix Products Div. 104
Chance Vought Aircraft, Inc. 104
Chrysler Corp., Missile Div. 101
General Electric Co. 102
Marquardt Aircraft Co. 104
Republic Aviation Corp. 105
Ryan Aeronautical Co. 103

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ALUM CAPACITORS. A new line nte-anode tantalum electrolytic tors, designed to meet the need ry small polarized capacitors used iaturized circuits, is on the market. pacitors are said to have low leakcurrents and low power factors g between one-third to one-half maximum limits specified in MIL-5B over the entire operating temre range. ITT Components Di-

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SISTOR AMPLIFIER. This new ain, narrow-band voltage amplifier igned to operate from printed cir-esolvers and other very low level s with carrier frequencies from 60 20 KC. Taber Instrument Corp.

No. 227 on Subscriber Service Card.

WRENCHES. "B" nut wrenches de-l specially for the missile industry been placed on the market. Torqu-OX lines has presented a problem past because of the extreme high needed to stop leakage. These tools are designed for the Thor am, and are being used by Doug-well as Convair. Spec Tool Co.

No. 228 on Subscriber Service Card.

E FILTERS. A new Chebishev-type Pass and Low Pass Electrical Wave s, with cut off frequencies up to C, is available. These custom de-d filters feature high attenuation, nseration loss and stability over a temperature range. Polyphase In-nt Co.

No. 229 on Subscriber Service Card.

VIBRATION TESTING. A compact sine wave vibration testing system, the Sine-O-Matic Model CP-¾, has been placed on the market. A completely packaged testing system, the unit features fully automatic programming and operation. Ling Electronics, Inc.

Circle No. 230 on Subscriber Service Card.

SOLENOID VALVE. Designed for missile applications, this 4-way pneumatic solenoid requires only 0.2 amp at 27 volts DC. The valve weighs 11 ounces, and operates with pressures up to 3000 psi. Dynamic Controls Corporation.

Circle No. 231 on Subscriber Service Card.

SWITCHING TIME. A device for testing transistor switching times, incorporating a new precision technique for measuring durations in the millimicrosecond region, has been announced. Designed specifically for analyzing the time characteristics of high speed transistors, the APL 300 can measure the switching time of the leading or trailing edge of the output pulse, with an error of 3.0 millimicroseconds. Atronic Products, Inc.

Circle No. 232 on Subscriber Service Card.

CAPACITOR. Just introduced is a miniature solid electrolyte tantalum capacitor—said to be rugged, reliable, and exceptionally stable in capacity, dissipation factor, and leakage current over a temperature range from minus 80 degrees C to plus 85 degrees C. ITT Components Division.

Circle No. 233 on Subscriber Service Card.

REFERENCE STRINGS. A new line of reference strings designed for an extremely low amount of voltage change over a wide temperature range is on the market. These strings were designed for applications where voltage output and temperature coefficient requirements are not compatible with the performance of a single diode, such as in the precision instrumentation field. Hoffman Electronics Corporation.

Circle No. 234 on Subscriber Service Card.

MISSILES AND ROCKETS

SEPTEMBER 8, 1958

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51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75
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101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125
126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150
151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175

• • Missile Literature

200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224

• • New Missile Products

225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249
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MISSILE LITERATURE

TERMINALS. Mitronics, Inc., has new literature and prints available for high altitude, high voltage, Solderseal Terminals, as well as literature for high and low temperature metallized ceramic and alumina for Hermetic Seal applications.

Circle No. 200 on Subscriber Service Card.

GEAR-HEAD PUMP. A bulletin just released by the Blackmer Pump Company of Grand Rapids, Mich., describes a new line of gear-head rotary pumps with a new helical gear reducer developed by Blackmer especially for use with these pumps. Detailed in bulletin 110, are three series, the GX, GXS and GXU, each of which is available in sizes of 2", 2½" and 4". Pump capacities range from 30 to 525 GPM with maximum pressures to 100 psi.

Circle No. 201 on Subscriber Service Card.

GYROS. A new 64-page of illustrated Gyro Primers, prepared by the Norden division, United Aircraft Corp., explains how gyros work, gyro terms, and gyro operating principles. Specifications for rate gyros, free gyros, directional gyros and compensated vertical gyros are included in this informative book.

Circle No. 202 on Subscriber Service Card.

CRYSTAL FILTERS. A four page technical bulletin (10.7) on the Hycon Eastern 10.7 Mc family of Crystal Filters shows vacuum tube and transitor circuitry, pulse and impulse response photographs, attenuation versus frequency curves, and block diagrams.

Circle No. 203 on Subscriber Service Card.

TIMING. A four page brochure containing graphs for computing cumulative errors in electronic clocking is now available from Hycon Eastern, Inc. Theory is discussed and two examples on the use of the graphs are shown. Hycon Eastern Timing Equipment is described.

Circle No. 204 on Subscriber Service Card.

GENERATOR CONTROL. The new Magaset dual-mode excitation system for AC generator control is described in detail in a new bulletin, 8.010, available from Electric Regulator Corp. Using circuit schematics, principles of operation, actual performance results, specifications and installation data are fully covered.

Circle No. 205 on Subscriber Service Card.

MERCURY SWITCH. Micro Switch, a division of Minneapolis-Honeywell Regulator Co., has issued a new data sheet (#149) on the ultra-small catalogue listing AS419A1 mercury switch. The data sheet gives standout features of the tiny switch—only 9/10 in. long and weighing 1.8 grams complete with leads. Long life, extreme compactness sensitivity of the switch suggest m uses in supersensitive control dev which demand outstanding switch ability.

Circle No. 206 on Subscriber Service C

GEARS. Geartronics Corp. has iss a bulletin, "Facts and Figures," wl lists the availability of a wide var of gears, power transmission comp ents, precision machined parts engineering help.

Circle No. 207 on Subscriber Service C

FOCUS COIL. Syntronic Instrume Inc., Addison, Illinois, has issued advance technical bulletin giving mensional drawing, electrical and chanical characteristics and comp technical details on its new Type F electromagnetic focus coil designed photographic, flying spot, military other special purpose 1½"-neck ameter cathode ray tubes.

Circle No. 208 on Subscriber Service C

MICROSPHERES. A new 8-page il trated brochure entitled "Eccospher is now available from Emerson & C ing, Inc., Canton, Mass. The broch describes a hollow glass microsph product which is used as a dielec material in molding compounds, domes, heat barriers, foams, cast resins.

Circle No. 209 on Subscriber Service C

ACHIEVEMENTS. This new 56 p illustrated brochure briefly descri the facilities and achievements of Cook Research Laboratories, a divis of Cook Electric Co., Chicago. Cook Research Laboratories has b providing basic and applied resea development to industry and gove mental agencies since World War Significant achievements (as illustra in the brochure) have been made several fields; including the devel ment of complete systems for data cording and reduction radar, c puters, aircraft and missile contr parachute recovery and instrumentati outer space research, and basic applied research in electronic and clear applications.

Circle No. 210 on Subscriber Service C

THERMAL VALVE. A new data sh containing detailed information specifications for the new, leakpr miniature thermal relief valve, has b published by the Fluid Regulat Corp., designers and manufacturers hydraulic and fuel valves. The sm sized, lightweight unit relieves exc pressures caused by thermal expans of fluids in a closed system.

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126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150
151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175

• • **Missile Literature**

200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224

• • **New Missile Products**

225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249
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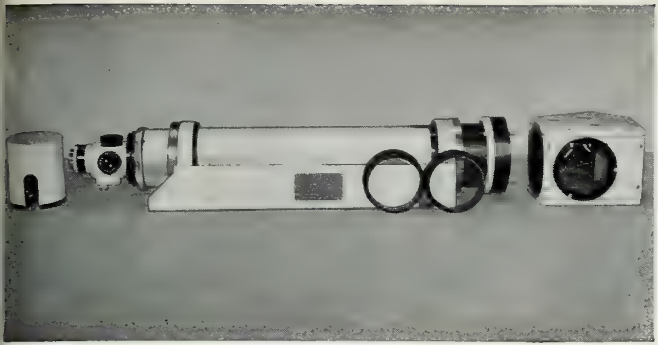

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Measures within a pencil's width at a mile.

Kollmorgen instruments like these are bridges between the eye and the invisible.

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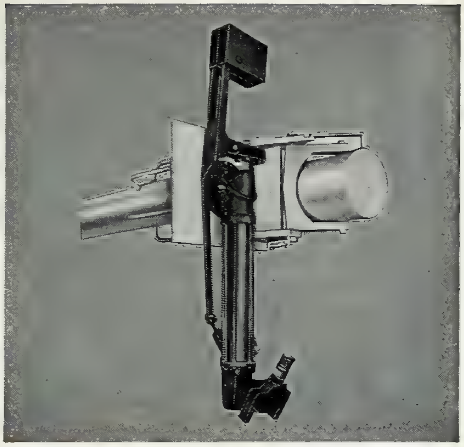

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Circle No. 4 on Subscriber Service Card.

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Electro Instruments
A-12 DC amplifier
totally transistorized

equal to or better than the best vacuum tube instruments!

The new Model A-12 DC Amplifier is the preferred systems link for amplification, normalization and impedence transformation. Use of solid state elements assures maximum reliability; power dissipation is only seven watts. Mil-type components are mounted on coated plug-in printed circuit boards for protection against vibration and corrosion.

versatility plus economy

Electro Instruments produces a series of plug-in mode selectors and attenuators for the A-12: single ended, differential and operational, fixed and variable gain.

Eight to a rack
The A-12 is packaged for high density use; mounts eight across in 19″ relay rack panels.

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	Single Ended Input
Gain:	Fixed gain set to any value from 10 to 1000 inclusive by front panel plug-in units. Gain switching plug-in attenuator available with gains of 0, 10, 20, 50, 100, 200, 500 and 1,000. Adjustable upward 6db from setting with potentiometer.
Input Impedance:	100 megohms shunted by 0.001 mfd (typical).
Source Impedance:	5K or less (to meet noise specification).
Drift:	Less than 2 microvolts in 200 hours at constant ambient temperature. Less than 0.4 microvolt per degree centigrade.
Ambient Temperature:	0° to 50°C.
Noise (Referred to input):	0-3 cps 5 microvolts peak to peak 0-750 cps 4 microvolts rms. 0-50 kc 8 microvolts rms.
Frequency Response:	±3db to 50 kc (typical); ±1.0% to 2 kc
Output Capability:	±10 volts at ±100 ma DC or peak AC to 10 kc

Write today for complete specifications on single-ended, differential and operational models.

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Electro Instruments, Inc.
3540 Aero Court
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SEPTEMBER 15, 1958

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

News and Business Edition

AN AMERICAN AVIATION PUBLICATION

sequoia cable/cable assemblies/cable systems

The cable that carries the pulse-beat of a giant missile or the control signals for a weapons defense system also carries an immense responsibility: its reliability must be nothing short of absolute.

To make cables, assemblies and systems of this high order of reliability, Sequoia Wire & Cable has augmented its own wire and cable facilities with the extensive experience and production capabilities of a long-established cable assembly organization, the former Douglas Roesch Company (more recently known as Hall-Scott Electronics).

This combination of forces, comprising over 600 people and 170,000 square feet of space, under the forward-looking management of Sequoia Wire & Cable, brings to the cable user the most comprehensive and highly integrated production facility in the industry. In every phase of the entire cabling operation, from drawing the basic wire to the successful completion of an operating system, Sequoia is thus enabled to maintain rigid quality control and to offer completely undivided responsibility. The practical result is cable of better functional design with superior mechanical and electrical reliability.

Sequoia offers advanced materials and techniques for extreme-environment applications, backed by key-man experience in such projects as NIKE, THOR, REDSTONE, FALCON, POLARIS, AJAX, HERCULES and ATLAS. For routine applications, as well as custom-engineered projects, Sequoia maintains the largest available stock of cable components. Write for details.

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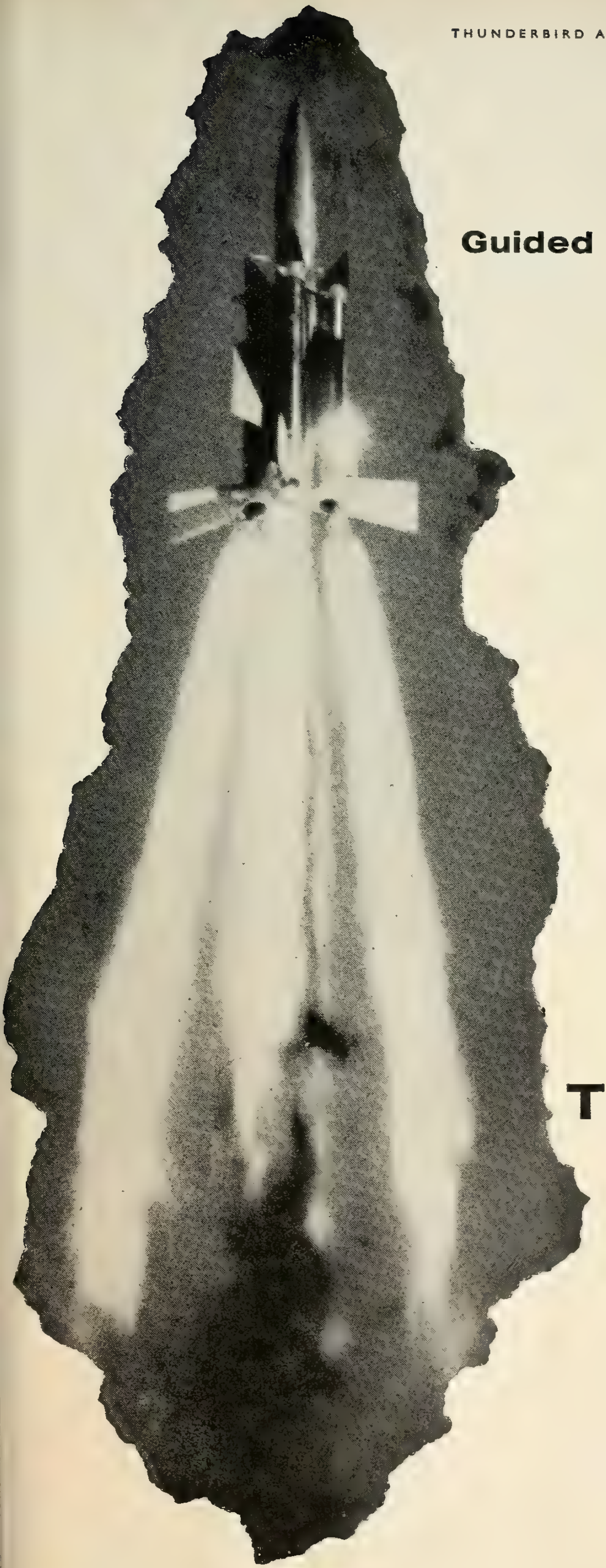
THUNDERBIRD AND ITS BACKGROUND



Guided weapons are no sideshow at ENGLISH ELECTRIC

A whole, new and separate Division was created some ten years ago, within the ENGLISH ELECTRIC group to handle the design and development of Thunderbird and all the equipment that goes with it.

It embraces a comprehensive team covering all the engineering techniques associated with missile development and manufacture and capable of standing on its own feet—though it can also call on all the resources of knowledge, research and production of the entire ENGLISH ELECTRIC group.

It is the only such wholly self-contained and completely self-sufficient organisation in this country—and one of the very few such in the Western world.

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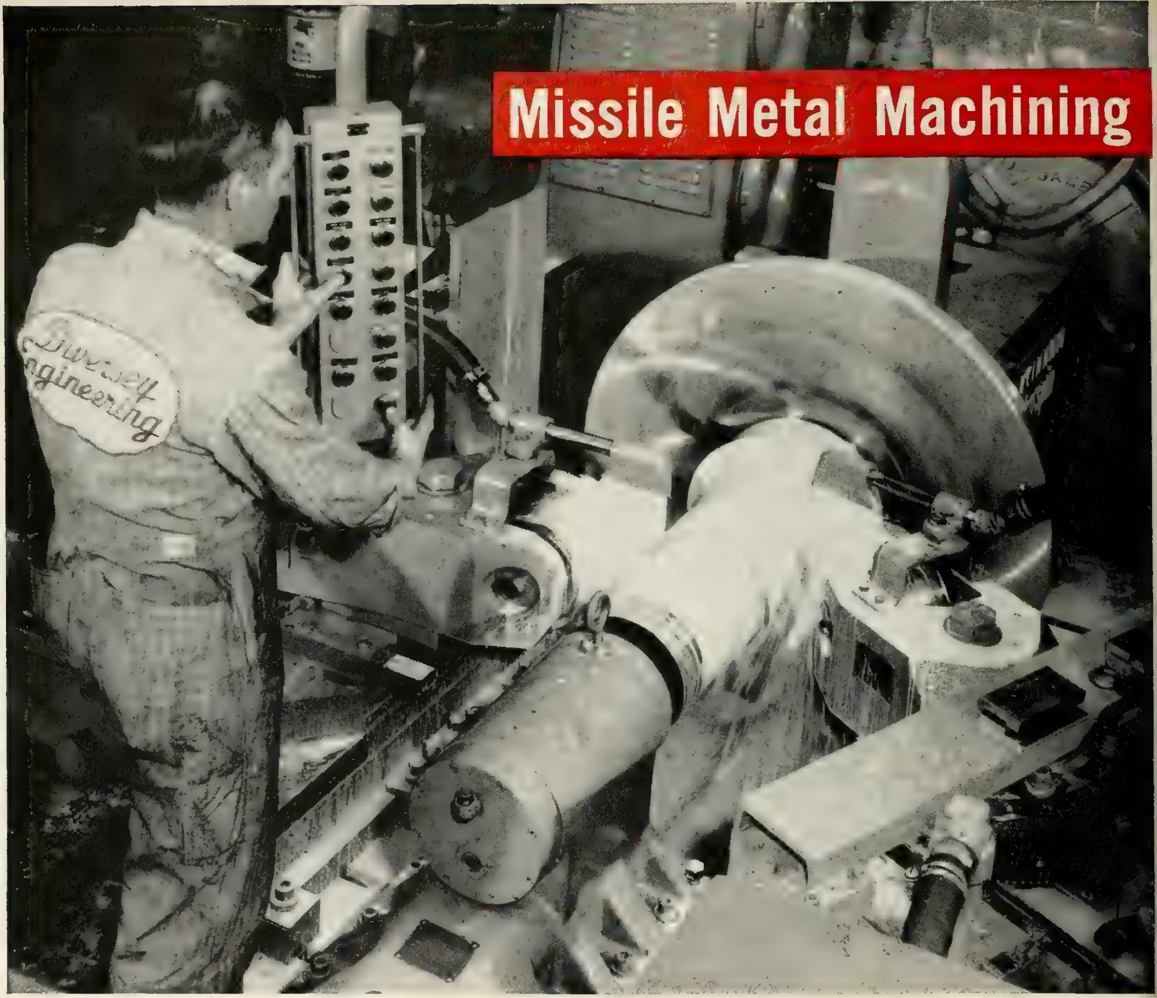

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SEPTEMBER 15, 1958
VOL. 4, NO. 11

missiles and rockets

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editorial viewpoint . . .

It's much easier to comment on what has not been done than what has been done in appraising the President's leadership in the post-*Sputnik* era of almost a year.

After October 4, the Administration made flat promises that every effort would be made to give this nation a stronger defense and a hard-hitting space program; and that more money would be forthcoming for such a program. It was implied that prompt decisions would be made in the "gray" areas of civil vs. military projects; appointment of competent leaders, who could contribute materially to needed reorganization of thinking and action, would be made without regard to politics and Pentagon pressures.

But today there is a turnabout, and a new line. It is said that we are still stronger militarily than Russia, that we can win either a limited or a general war, and that we can't take the chance of spending ourselves into bankruptcy by buying unproven space-age weapons.

Senator Stuart Symington (D-Mo.) has picked up this reasoning, and challenged it point by point as a threat to the nation's security.

For one thing, says Symington, defense expenditures are up only 1.3% (about enough to account for depreciation of dollar value) since *Sputnik* I. For another, he doesn't believe the U.S. can match Russia in all categories; and that too much of defense is being built on the basis of tradition, rather than progress. He also points out that "incredible" lack of airlift hampered swift landings in the mid-East; and that the Army's *Nike* program is out of date, mainly because the ability to shoot down a bomber at 50 to 100 miles is not too effective against rockets air-launched 2,000 miles away.

Even though Congress gave the Administration more money for defense than it asked, there is no doubt that the military has found itself laced too tight in the financial straitjacket imposed upon it by a leadership that has bowed to "economy politics" in an election year.

If there is any apathy or complacency on the part of the American people, it is no less than the nation deserves, considering the lack of foresight of the Administration. The fault should be clearly placed at the doorstep of 1600 Pennsylvania Avenue.

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contents

news

Guidance Breakthrough Seen In Underwater Missile *by William O. Miller* ... 10
President Appoints Space Council Members 11
How The *Pershing* Contracts are Divided *by Donald E. Perry* 12
IAF Pushes World Astronautics Academy *by Erik Bergaust* 19
Missiles In The News 26
U.S. Proposes Four-Point World Space Plan 28
McCormick Selph Diversifies for Growth *by Richard Van Osten* .. 32

departments

Washington Countdown 7
Industry Countdown 9
Missile Business 21
Missile People 34

columns

Propulsion Engineering 25

cover

Maj. Gen. Bernard A. Schriever, commander, Air Force Ballistic Missile Division of Air Research and Development Command, ramrod for Air Force's lunar probe attempts. (see page 17)

Leading organizations in the aircraft and rocket industries look to L·O·F Glass Fibers Company for the new developments in both thermal and acoustical insulating components. They know this is *the only company in the glass fiber field* which performs all five of the following:

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washington countdown

Army is worried over the future for *Nike-Ajax* and *Hercules* programs. Pressure from a cost-conscious Congress will force Secretary McElroy to make a decision between *Nike and Bomarc*—which may result in a slowdown on one missile, rather then sudden death. *Nike-Zeus* probably will continue to have high priority as AICBM.

The difficulty of McElroy's decision lies in the really small differences between contending missiles. The current *Bomarc* model, for instance, has a slight edge over *Hercules* in range But *Hercules* is simpler and cheaper to operate, and can be phased into existing *Nike* facilities.

Seven more AF lunar probes may be in the making. There will be many Allegany Ballistics Laboratory-developed third-stage rockets of the *Vanguard* program delivered to Air Force for its *Thor-Able* combination. Note: The ABL rocket is untested on *Vanguard,* did not fire on the first lunar shot.

Don't expect fast action on the U.S.'s proposal (see also p. 27) for peaceful exploration of space. The plan, in detail, is even more complex than the centuries-old attempt to outline freedom of the seas. Many observers see the move by the U.S. As a political one to gain public-relations initiative. Some even see the move as dangerous to U.S., since it would apparently tend to freeze development in its present state—with Russia ahead.

AF is bothered, after its brass got a look at the October issue of Army News Digest The pamphlet-sized Digest is entirely devoted to a well-presented discussion of Army's role in the space age. What bothers Air Force is that Army discusses space as a military realm—and one which it could handle adequately alone. AF says it has been abiding by a ruling that forbids discussion of space on military terms.

Successful flight of Australia's *Black Knight* rocket, from the Woomera Rocket Range, is being watched closely from Washington. Another major ally with rocket capability of its own is welcome. Actually, *Black Knight*—first major experiment with a large ballistic rocket by the British Commonwealth—is rated a tremendous stride, after a very slow start. The new rocket (Saunders-Roe), is 35 ft. long, 3 ft in diameter, reached an altitude of 400 miles—well over any single-stage U.S. research rocket.

Dissension in the worst possible place—right at home—is reported in Navy's Bureau of Ordnance, over the BuOrd's Special projects team for *Polaris.* Non-team member civil service people are griping over higher salaries, less work (they say) for team participants.

Matador might be first U.S. missile used in a shooting war, if anything serious (from a U.S. point of view) develops out of current bombardment of Chinese offshore islands. With a range of up to 700 miles, and guidance centered around a hyperbolic grid system (and nuclear warhead capability), *Matador* is already based on Formosa.

Signing of renegotiation act extension for six months is counted as a victory by manufacturers, who fought hard against law during recent Congress. Although new act extends some provisions the manufacturers dislike, the "victory" comes in this way: As written, the extension carries an implicit promise that Congress will give the whole statute a thorough airing during the next session. Permission to appeal Tax Court decisions to the U.S. Court of Appeals is one of the things industry may get out of any restudy of the law.

Heavy emphasis on space is obvious in announced program of closed-session discussions of the Air Force's Logistics Discussion Group at Maxwell AFB next week. First-day speakers will include Dr. Hugh L. Dryden of NASA; Dr. W. R. Dornberger, of Bell; Dr. Krafft Ehricke, of Convair—and J. A. Johnson, Air Force general counsel, who will discuss space law. Maj. Gen. L. I. Davis will talk later on reliability and environmental testing.

OCT. 20-30...PROJECT WILLIAM TELL...

RYAN FIREBEES TEST AMERICA'S AIR DEFENSE IN FIRST WEAPONS MEET TO USE JET TARGETS

Ryan Firebees are the exclusive flying "bull's-eyes" for the Air Force Project "William Tell"—first weapons meet to use free-flying jet targets. 100 Firebee jet drones will test the pilots, planes, and missiles of America's air defense system under the most realistic "combat" conditions ever achieved.

Firebees will not only draw the fire of the nation's crack Air Force pilots: they will score the results in mid-air with a new electronics system. A running record of hits, misses, and near-misses will be instantly transmitted from Firebees to scorekeepers on the ground. Other Firebees will photograph missiles boring in—or streaking away if they don't score a "hit."

Pitted against the Firebees in this world-wide weapons meet will be the top Air Defense Command squadrons, flying Convair F-102, Northrop F-89J and North American F-86L interceptors. They will fire deadly Falcon guided missiles, and Genie and "Mighty Mouse" rockets.

Only the Firebee—the most advanced target drone—has the high performance, reliability, and extended duration needed for realistic weapons evaluation. In service with the Air Force, Navy, and Army, Firebees are flying in greater numbers and for more hours than any other jet target drone.

The Firebee is another outstanding example of Ryan skill in blending aerodynamics, propulsion, and electronics knowledge to produce a superior product.

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Ryan Aeronautical Company, San Diego, Calif.

industry countdown

paperwork down

Mountains of paperwork for missile manufacturers might dwindle a bit. Gen. E. W. Rawlings, Air Materiel Command chief, gave the tipoff in orders to materiel areas in which he said he wants reports from industry limited to those "urgently needed." Missile makers —recently upset over plans for voluminous Missile Makers Planning forms (m/r August 4, p. 12)—could breathe "amen." The general's prime example: one major contractor is now submitting some 81 Budget Bureau reports, 141 other reports. Spending time is equivalent to the work of 700 persons a year.

price redetermination

DOD proposals to modify price redetermination contract clauses worry Electronics Industry Assn., Aircraft Industry Assn., and others. Reason: an "undue emphasis" on obtaining cost information, which industry insists gives contracting officers a blanket authority to demand any information they might consider to have a bearing on price redetermination. Under such authority, a whole new set of accounting records—in addition to regular financial records—could be required. Another reason for worry: DOD's new proposal, in effect, might convert fixed-price contracts into cost-type contracts.

buy British?

English manufacturers reportedly are making yet another attempt to break U.S. policy of buying only U.S. products to support its forces stationed in Britain. Latest effort centers around the offer of British-produced rocket launchers made of fibre glass.

personnel

Three high-ranking military men, with background and experience in missile-related fields, beefed up top missile makers this week. **RAdm. John A. Scott,** with a long naval record in aircraft and undersea missions, joined **Link Aviation** as Coordinator of Military Requirements; **Maj. Gen. Arthur W. Vanaman,** former commandant of the Industrial College of the Armed Forces, became assistant to President Dan A. Kimball of **Aerojet-General Corp.; Col. Harry G. Spillinger,** former chief of production engineering staff division, Air Materiel Command, is now manager of systems reliability and safety control for **Boeing Airplane Co.**

business in satellites

Emphasizing the continuing importance of earth satellite programs for business is **Lockheed Missile Systems'** assignment of top weapons management men to Air Force satellite development. **J. H. Carter,** who heads the satellite program, has been given two assistants—one for systems management, the other for "future applications." Systems aide is **D. J. Murphy,** who headed the division's project systems branch; "futures" aide is **R. M. Salter,** formerly assistant project manager.

money tightens

The inflation-wary **Federal Reserve System** had news for businessmen: discount rates at two more of its branches—Chicago and Minneapolis—will go up from 1¾% to 2%. That makes a total of six (out of 12) Fed branches that have raised rates—which means a tightening of money available to commercial banks and business borrowers.

money eases

The Office of Civilian Defense Mobilization has ok'd accelerated amortization on seven missile research and development projects for the Martin Co. (involved in development of the *Titan);* and approved similar fast amortization for J. C. Carter Co., Costa Mesa, Calif., for development of aircraft and missile parts.

Here's First True Underwater Guided Missile

Wire-Guided Torpedo—With New Type Propeller For High Speed—Seen Major Breakthrough in Anti-Submarine Warfare Techniques.

by William O. Miller

The U.S. Navy shortly will begin to receive its first real underwater guided missile.

Though the project has been under development for several years, the first concrete evidence that success is near came with the announcement of the Mark 39 wire guided torpedo, developed for the Bureau of Ordnance by Vitro Laboratories of Silver Spring, Maryland.

Coupled with the almost simultaneous announcement of development of a supercavitating propeller, the Navy has made what amounts to a major breakthrough in anti-submarine warfare. This is in addition to advantages against surface targets.

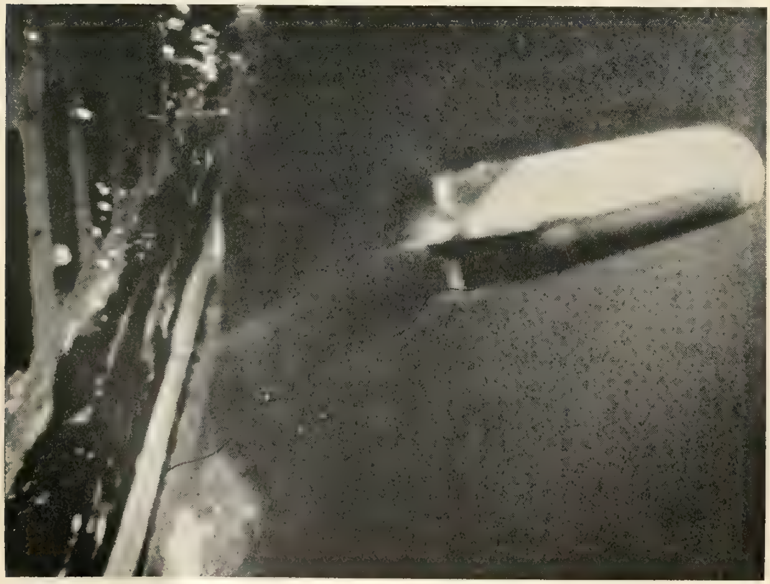
Evasive action, the best defense a submarine has against torpedoes, is more or less nullified by the ability of U.S. submarines now to transmit signals to the Mark 39 torpedo to guide it to an enemy vessel. Time for the evasive action will be materially reduced by the supercavitating propeller which will permit underwater torpedo speeds in excess of the present efficiency limitation of about 50 knots.

• Wireguide—The fine wire over which the signals are transmitted plays out from a spool in the torpedo and a spool in the submarine. While presently in only limited production, a number of U.S. submarines have certain parts of the system already built into them which will permit their employment of the Mark 39 as soon as it is made available.

The controller had a keyboard of small switches by which he controlled the torpedo and exploded it. It was built for a European power but manufacturing rights for two were sold to the U.S. Navy.

•Super prop—The supercavitating propeller recently demonstrated at the David Taylor Model Basin was the direct result of work done in the field of hydrofoils by Marshall P. Tulin while at the Model Basin.

Cavitation is the formation of cavity of water vapor on the surface of the rapidly revolving propeller blades. As the propeller turns faster, the cavity builds up. There is a reduction of the efficiency as the cavity collapses causing vibration, noise and erosion of the blade. The hydrofoil section of the Tulin blade elongates the cavity and as it becomes longer than the width of the blade, supercavitation is said to exist. This turns the former detrimental effect of cavitation to an advantage with a much higher efficiency rating and higher rotational speeds.



Wraps have been taken off of the Navy's first real torpedo breakthrough in several years with the announcement of limited production of the Mark 39, wire-guided torpedo. The range of the Mark 39 has not been released.

Navy Makes Vessel Subsystem

It's more than a play on words that the Fleet Ballistic Missile submarine is a subsystem. For the first time the Navy is making a vessel a subsystem of a weapons system. The five subsystems of the nuclear powered, *Polaris*—equipped, system (now officially designated SSBN . . . Submarine Ballistic Nuclear) are:

1. The missile.
2. The fire control equipment.
3. The navigation equipment.
4. The launching equipment.
5. The submarine.

Bendix *Dyna-Soar* Role Outlined

According to Dr. Russel D. O'Neal, Bendix divisional general manager, Bendix Aviation Corp.'s Systems Division at Ann Arbor, Mich., will head the company's participation in the Martin-Bell *Dyna-Soar* project.

Dyna-Soar, a joint Air Force-industry project, is aimed at developing a manned vehicle capable of circling the globe in approximately two hours. The Martin-Bell team, as well as another team headed by Boeing Airplane Co., is currently performing the necessary research and development work to design a practical model of the *Dyna-Soar* "booster-glider" in approximately 12 months.

Bendix will work on communications systems, telemetering systems, hydraulics, electrical power conversion, cabling, and electrical connectors.

In addition to the Systems Division, the following Bendix affiliates will participate in the program: Bendix-Pacific, North Hollywood, Calif.; Bendix Radio, Baltimore, Md.; Scintilla Division, Sidney, N.Y.; and Red Bank Division, Eatontown, N.J.

In his statement, Dr. O'Neal said: "The man-machine combination to be evolved in this program must be designed to withstand extremes of temperature and other extraordinary environmental conditions that, up to now,

Named to Space Council

APPOINTED MEMBERS of the important Space Council of the National Aeronautics and Space Administration are: (top, right): Dr. Alan T. Waterman, director of the National Science Foundation; Dr. James H. Doolittle (left) chairman of the National Advisory Committee for Aeronautics; (right): Dr. Detlev W. Bronk, president, National Science Foundation; William M. M. Burden, (left) former Assistant Secretary of Commerce. Other members include the President, Secretary of State John Foster Dulles, Defense Secretary Neil H. McElroy, and Atomic Energy Commission Chairman John A. McCone.

have never been encountered in piloted flight.

"For example, a major problem will be radio communications through the electrically charged, or ionized, particles that surround an orbital vehicle. Bendix has had these environmental problems under investigation for some time, and it is in this area that we hope to make a major contribution to the *Dyna-Soar* program."

The Systems Division's *Dyna-Soar* Project Office will be headed by Robert H. Johnsen. Thomas E. Lynch will coordinate Bendix activities in the study of radio propagation, communication, and navigation.

The torpedo and its director, in addition to the wire technology, were developed by the Silver Spring Laboratories of the Vitro Corporation of America. While Vitro is manufacturing the directors, the Mark 39 torpedoes are being produced by the Philco Corporation.

Vitro has been on the Bureau of Ordnance's torpedo and guided missile program since the company was formed in 1948. The company's contracts have included not only underwater weapons such as torpedoes, mines, (and mine counter-measures), but through successive contracts, Vitro has taken part in every Navy ship's system with the exception of the USS Gyatt, which was the first destroyer to employ the *Terrier* missile.

Vitro has been most active in the development of weapons systems engineering for the Navy. As one company spokesman put it:

"It is our job to eliminate the gross incompatibilities of the components of a weapons system. Our goals are reliability, simplicity and a reduction in the cost of a given system."

While maintaining a continuing interest in *Terrier* and *Talos* programs, the company has been more active in recent years in coordinating the control systems for various type ships and in several phases of the *Polaris* Fleet Ballistic Missile program.

The company was among those who recommended and pushed for an underwater ejection system for the *Polaris*, and for the Navy's activity in the solid fuels field for the *Polaris* and other missiles.

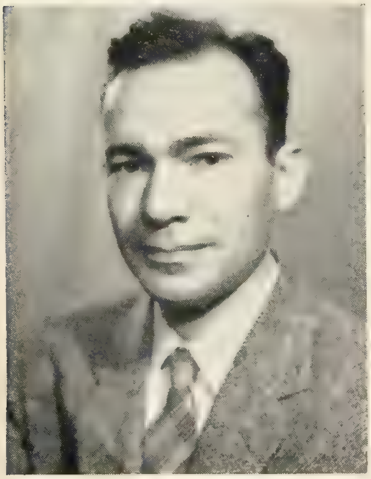
• **Underwater Interests**—The company's interest in underwater weapons and systems has been heightened in recent years. Emphasis has been placed on all phases. As an adjunct to other programs, Vitro has developed for the Navy in-service training programs in underwater sound and underwater television.

No other firm is performing exactly the same function Vitro does for the Navy, but all of its contracts have been obtained in competition. Unlike the system employed by the Air Force with Ramo-Wooldridge, Vitro has no voice in the selection of the contractors for the various parts of the weapons system it coordinates.

Incidentally, the idea of the wire-guided torpedo goes back to 1877 when John J. Lay held a public trial of the Lay torpedo in Cleveland, Ohio. The Lay torpedo was steered by a double rudder controlled by means of electricity through the cables which, as Harper's magazine reported, "lies coiled like a harpoon line in a whale boat and is paid out as the boat pursues its way. This cable," the report continues, "may be of any length desired, and connected with the shore or a vessel."

Assistant Army Secretary Higgins ". . . *Pershing* will set future standards"

Martin Procurement Director C. A. Blaney . . . he'll spend $1 billion.



***Pershing* Operations Manager Sid Stark ". . . no engineering problems"**

Getting Set For *Pershing*

Army Outlines Procedures for Spending Billion

by Donald E. Perry

HUNTSVILLE—The *Pershing* missile—Army's "in-between" approach to weapons development—spells good business ahead for big and little firms.

The reason: some 60% of the Martin Company, Orlando Division's prime contract dollar—unofficially expected to exceed $1 billion in the next three years—will go for outside procurement. There's even a contract guarantee to allow new firms to participate. Further, this method of doing business should aid in shortening development from a weapons system norm of seven to four years.

Let's look at the Army philosophy back of *Pershing*. There are two principal methods in weapons development. One is the prime contractor approach, where the major share of funds go out on contract to industry, which in turn fabricates. Only standards requirements and monitoring are performed by the government.

The other is what has been referred to as the Army's "arsenal concept," the system used for the *Redstone* and *Jupiter* programs. This is a complete in-house capability to act as a prime contractor to carry a system from concept, through design and development, to prototype and manufacture. Industry then receives the volume production task.

Army, often critized by industry for its arsenal approach, believes an optimum approach for government is somewhere in between, and *Pershing* is the test. Assistant Army Secretary for Logistics, F. H. Higgins, says "this approach will set the standards for future Army systems development."

• **Prime responsibilities**—*Pershing*'s development will work this way: AOMC, which conceived the system, will guide, manage and monitor the prime contractor with its in-house technical competence. Army feels strongly about retaining this competence instead of relying on what often has been referred to as "Pentagon Engineers," the quasi-competents who often hold up decisions when they tangle with industry personnel.

On *Pershing*, industry is wondering how much of a whip-hand the Army is wielding on selection of major subcontractors. Also, whether Martin and the major subs will be virtually free—as under the prime concept—to choose and monitor the work of minor suppliers.

Army Ordnance Missile Command at Huntsville answers this way: Martin and AOMA "cooperatively" selected major subs with Army retaining rejection rights. It is not contemplated that the Army will have to provide technical concurrence beyond that tier. Martin, in most instances, will retain its prime individuality.

However, AOMC has insisted on a contract clause with Martin and major subs which should have far reaching effect. They will have to furnish documentation "necessary to enable a manufacturer experienced in industrial production, but new in the missile field, to undertake production in any area of the *Pershing* system." This, Army feels, should guarantee that at least 35 to 40% of the dollar volume will go to small business.

Martin, according to its Procurement Director C. A. Blaney, is assuring this will be done, not only in the *Pershing* program, but in other areas of company business. He furnishes these facts:

When the Orlando division was set up less than two years ago, Martin wrote almost every small supplier in the southeastern U.S., asking their capabilities. This has provided a remarkable source file of more than 2,000 firm names, which has been kept up daily.

Martin, which issues 6 to 7,000 purchase orders a month, has spent $58 million in procurement. Twenty percent of this was spent in Florida.

Facility teams, comprising inspectors, procurement and shop technicians, have inspected several hundred firms desirous of doing business with Martin and have given capability evaluations. This system has resulted in new supply sources.

Teams of new procurement specialists have been established to deal with more than 100 vendors who visit the plant daily. Specializing in new ideas, these specialists refer representatives to appropriate Martin departments, such as structures and guidance.

A commodity buying team for all indirect items has been established, allowing more procurement attention to individual projects such as *Pershing*.

Blaney explains that it's the desire of both Martin and the Army to eliminate any costly duplication of end items in the *Pershing* system. For example, if an item from *Redstone*, *Jupiter*, *Nike* or any other Army system can be used in *Pershing*, it will be.

...speaking of

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...from design through production

In January 1957, Douglas Aircraft Company, Inc., contacted FMC regarding the design of ground support equipment for the IRBM-THOR they were developing for the Air Force. That same month, FMC engineers went to work in the Douglas plant—and the THOR transporter-erector, launching base, and power-pack trailer preliminary designs were developed.

At its own facilities in San Jose, FMC began subsequent engineering steps without delay, then produced and delivered the first operating unit in just 8 months—two months ahead of schedule.

Because FMC handled the entire project from design through production, with maximum coordination in every step of the program, this valuable saving in time was realized, and today, THOR equipment is being built at FMC under a production contract.

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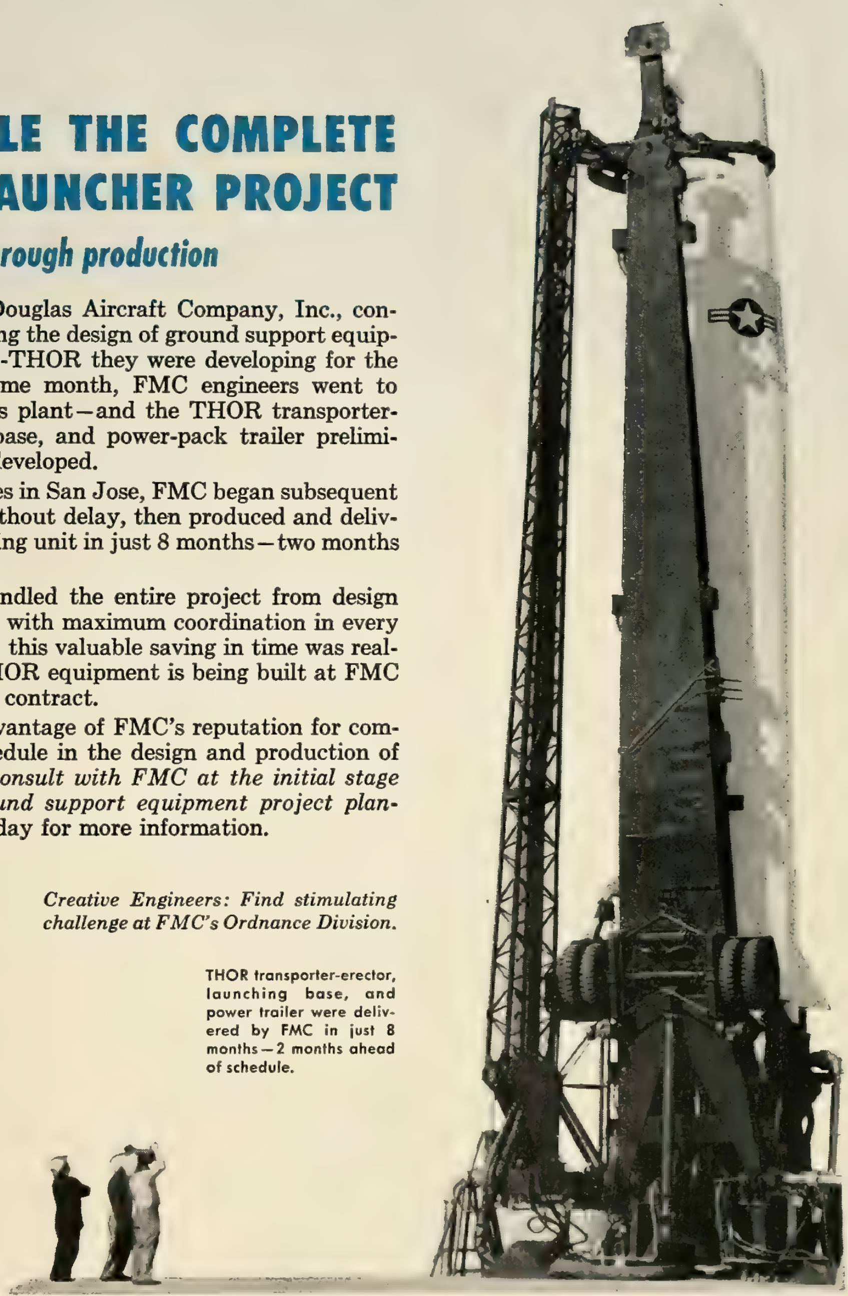
THOR transporter-erector, launching base, and power trailer were delivered by FMC in just 8 months—2 months ahead of schedule.



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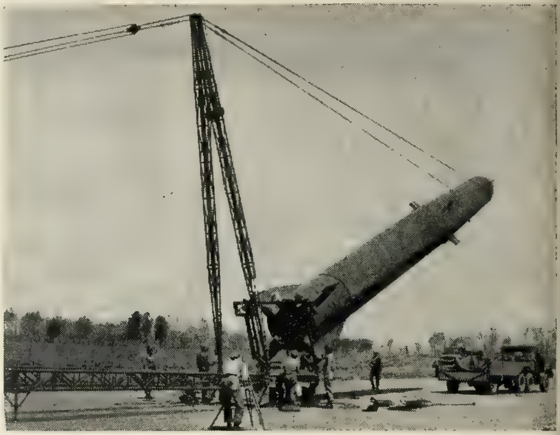
. . . spending billion for Pershing

EIGHT THOUSAND VENDORS and potential suppliers—many of whom are used in the *Pershing* program—are listed by the Martin Company's Orlando Division. Catalogue files in the background contain detailed information and sources.



LIGHTWEIGHT GROUND HANDLING EQUIPMENT, used in the *Redstone* system, will be employed with the Army's new solid-grain *Pershing*. Army expects to modify these frames, giving simplified mobility and readiness to the *Pershing* system.

This may result in a cost savings of five to 10%.

Martin is continuing its search for more suppliers, even though thousands have already been chosen for *Pershing*. "What we are searching for now are the bits and pieces close to our plant, because we like to do business in our own backyard," Blaney said.

- **Standardizing procedure**—Toward this goal, Army has provided Martin with lists of manufacturers, parts furnished, and drawings. Test results also are available. ABMA's Industrial Operations Division feels this is standardizing supply and engineering services, and will provide a lower cost weapon system. This may result in a one-third savings in the cost of preparing engineering drawings.

Army is also insisting that Martin and major subs come up with more stabilized design, so that items can be farmed out for formal advertised bidding. Sole sources of supply are being eliminated as much as possible.

Standardization is an Army byword for *Pershing*—starting with Assistant Secretary Higgins and continuing down the line. But new approaches to development will not be stifled by over-standardization. Higgins is not sure how this effort for standardization will work out.

"Our standardization efforts should make it a lower cost weapons system, but we also realize that this missile is expected to do more sophisticated things. We can save on standardization, but new developments—more precise range and so forth—might take up the difference. When a production norm is 20 to 30 missiles a month, you can't get overly enthused by standardization," he said.

Surprisingly enough, according to Sidney Stark, *Pershing* Operations Manager for Martin, no major engineering problems have cropped up. One area which has normally been a problem is liaison with subcontractors, but this has been remedied on *Pershing*. Resident teams have been set up at each subcontractor's facility. Team personnel include engineers, quality control and procurement personnel. Army also has a resident project engineer at Martin. In order to insure that *Pershing* gets proper attention, key personnel at Martin and each of the principal contractors can not be transferred without Army approval.

50 Prototype Models Planned

Army plans to produce 50 *Pershing* prototype models, with tactical testing scheduled for late 1960 or 1961. *Pershing* was conceived and designed by the Development Operations Division of the Army Ballistic Missiles Agency, Huntsville, Ala. Proposals were asked from some 30 firms in late 1957, with the award of a prime contract to the Martin Company.

Development under the Army Ordnance Missile Command was authorized by Secretary of Defense Neil H. McElroy, who eased Secretary Charles E. Wilson's previously-ordered 200-mile range for Army missiles. Decision has yet to be made whether Army will have operational use of *Pershing*.

***Pershing*'s test vehicle will have two stages, a 30-ft. length and a 24-in. diameter (m/r May, 1958, p. 72). Both solids reportedly will generate the same amount of thrust, with first stage separating at jet stream altitude. The test vehicle will have parachute recovery. A camera will be mounted in the final stage to take photographs within a four to five mile radius of the impact area. *Pershing* will have an inertial guidance system.**

The missile will carry a nuclear warhead, probably exceeding the *Polaris* warhead of 650-lb. Warhead development is under supervision of Picatinny Arsenal. All components, except engines, will be tested on Martin-Orlando property. Test firings will be at Cape Canaveral. Ground support equipment will be simple, with possible adaptations of existing *Redstone* items.

Major subcontractors are: Bendix Aviation Corp., Eclipse Pioneer Division, Teterboro, N.J., inertial guidance stable platform and associated equipment; Bulova Watch Co., New York, fusing and arming systems; Thiokol Chemical Corp., Huntsville, Ala., design, development and production of propulsion system; Thompson Products Accessories Division, Cleveland, transporter-erector-launcher.

Martin, which won the contract in a competition with six finalists (Army had asked 30 firms to submit proposals), did not have to add key personnel to the *Pershing* project. Personnel who were responsible for the proposal effort constitute the present team.

- **Final development**—Army's shift from liquid to solid propellant ballistic missiles understandably calls for more mobility and less ground support equipment. Engineers are stressing environmental control for the solid propellant.

Stark points out that below temperatures of –25 degrees and above 125 degrees F, there may be a problem of propellant grain cracking. With burning time more sensitive to temperature, designers may be forced to create environmental control kits for temperature extremes. It may be as simple as putting a plastic bag around the motor with thermal conditioning equipment inside.

Pershing can be handled in any attitude, and, importantly, can be checked out while horizontal. The system, which will use a small number of standard Army vehicles when these vehicles are developed, will be helicopter-aircraft-transportable and will have good cross-country maneuverability.

Due to Orlando's proximity to the Cape Canaveral test range, Martin will be able to avoid off-site field crews. All preliminary countdown and checkout will be at Orlando, allowing an early date for simulated tactical firing.

Nike-Hercules Tested For Mobility at Eglin

Results of recent Army *Nike-Hercules* test firings at Eglin Air Force Base, Florida, indicate that the air defense weapon has mobility to support Army operations in any part of the world, according to the Army.

An Army task force from Fort Bliss, Texas, commanded by Brigadier General John T. Snodgrass, tested the mobility of the anti-aircraft system using both air and ground transportation. The tests proved that every piece of *Hercules* equipment can be airlifted easily and quickly, the Army said.

The *Hercules* was fired at target drones flying in formation and successfully picked off the lead F-80 drone. It was the first firing of *Nike-Hercules* with live warheads near a populated area; and the first firing of two *Hercules* missiles simultaneously in salvo.

Industry Fights Contract Change

Current Department of Defense proposals to modify price redetermination contract clauses is causing widespread concern among military contractors as evidenced by the recent submittal of briefs by two industry spokesmen, the Aircraft Industries Association and the Electronic Industries Association (see also p. 9).

Both associations point out that an "undue emphasis" on obtaining cost information, stemming from certain reports submitted by the Controller General to the Congress as a result of isolated investigations, is causing the basic concern.

AIA and EIA, while fully recognizing that the goal of obtaining a fair and reasonable price for products is the basic purpose of price redetermination, charge that current clauses "have a tendency to give undue importance to the elements of price of components and subassemblies."

The real excuse for price redetermination, they say, is to arrive at a fixed price as soon as possible and to hold the administrative burdens involved to a minimum.

An important point argued by the associations is that fixed-price contracts should bear little or no relationship to cost-reimbursement types. Effect of the new clauses would be in large measure to convert the fixed-price contracts into cost-type contracts, through the use of price redetermination techniques.

- **Get a price**—One of the more important factors to industry is that the final price be fixed as soon as feasible, but in the current proposal, no definite time limit is set in which the Government must ask for additional cost information.

Because of this, industry is asking that a cut-off date be agreed to in advance both for the submission of cost and performance data. Otherwise, it appears that the Government could ask for the extra information right up to the date of the actual price redetermination agreement.

In this case, the contractor's only relief would be under the disputes section of the contract, under the terms of which a cut-off date would be provided. But here again, the contracting officer may delay in setting a cut-off date, with the end result that the entire fixed-price concept could be defeated.

The form and nature of the contract performance data itself is another point of contention. Spokesmen say that the information that a contracting officer is entitled to ask for ought to be agreed to when the contract is negotiated. One company says, "A contracting officer should not have a blank check for any information which he considers might possibly have some bearing upon price redetermination negotiation. Further, the form in which such information is supplied should be such that it can be readily determined from contractor's financial books and records and not perhaps require a whole new set of accounting records."

Actually, the yards and yards of records now being required as a result of such contract clauses are of mounting concern. A recent study showed that five contractors were forced to submit a total of 222 reports, only 81 of which has been approved in accordance with the Federal Reports Act.

Because of the strenuous objections voiced by the AIA and EIA, the Defense Department, in line with established procedures, will restudy the proposed price redetermination clauses before any action is taken.

Testing Failure Forces Lunar Shot Postponement

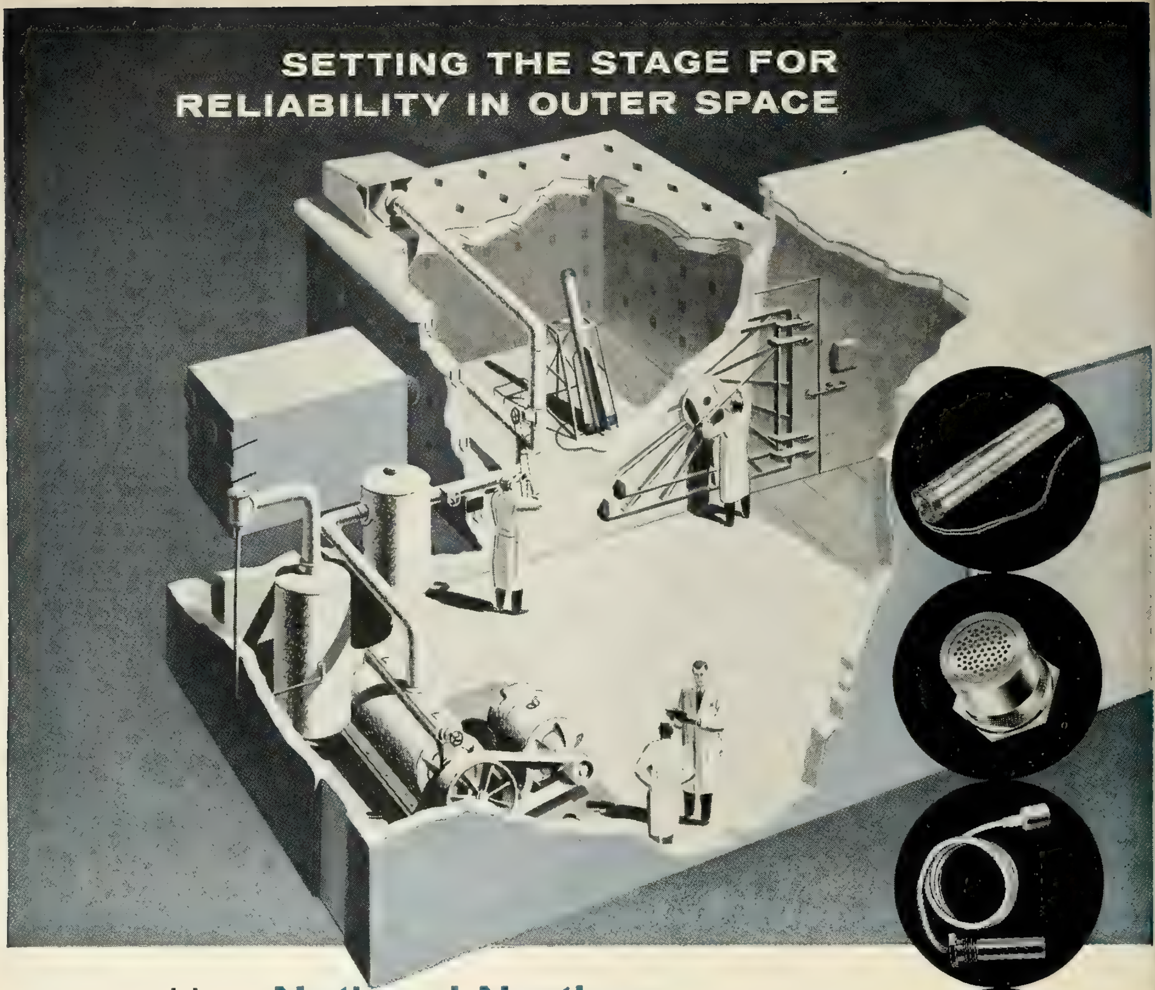
A failure during static testing of the Air Force's second lunar probe vehicle makes it unlikely that any firing attempt will be made this month. Firing date for the probe had been set for September 14.

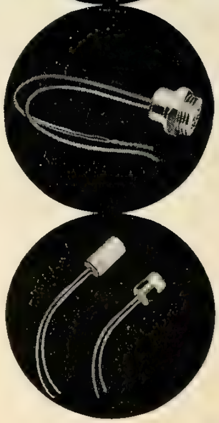
Advanced Research Projects Agency told m/r that the failure could not be remedied until at least September 17—three days beyond the optimum firing time—and this would weaken chances for the probe's success.

ARPA Director Roy W. Johnson, when informed by Air Force Ballistic Missiles Division of the trouble, issued orders that the probe would not be undertaken unless there is a maximum probability of success. ARPA declined to discuss the failure except to say that it has no connection with the failure of the first lunar probe vehicle. No official Defense Department explanation has been given for the August 17 failure but it has been speculated that it was caused by a rupture of tankage in the first stage *Thor*.

The next most opportune time for a lunar probe attempt with be the three-day period starting about October 12 when the moon again swings close to the earth. Russia—theoretically at least—will get two chances to reach the moon before the U.S. tries again. Best times for the Soviet Union are September 13 and October 11.

SETTING THE STAGE FOR RELIABILITY IN OUTER SPACE





How **National Northern** assures dependability in high altitude performance of ignition devices, pyrotechnics, and explosive components.

As depicted here by the artist, National Northern technical experts prepare their high altitude test chamber built in cooperation with the U.S. Navy, for surveillance studies to determine how extremes of temperature and pressure affect the performance of explosive charges. Through exhaustive environmental tests like these, National Northern Division of American Potash & Chemical Corporation can assure you of "built-in reliability" for the vital performance of propellants for rockets and missiles, explosives, pyrotechnics, detonators, igniters, squibs, gas generators, fuses, and related items. Years of experience in research, development, and production of literally thousands of these components for leading defense and commercial customers is the reason why National Northern should be your first choice for a solution to your problems in the design and production of packaged pyrotechnic and explosive components. Write today for your copies of National Northern's current technical bulletins and facilities brochure—"Missile and Rocket Power Technology." Address National Northern Division, American Potash & Chemical Corporation, P. O. Box 175, West Hanover, Massachusetts.

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Schriever Proved Long-Range Prophet

A forecast made 18 months ago in m/r—more a dream than a reality then—is coming true for Maj. Gen. Bernard A. Schriever, featured on this week's front cover.

It was then that the boss of the Air Force's present lunar probe program indicated to m/r that pioneering military research with IRBM/ICBM rockets would lead the way for the first peaceful scientific exploration of the lunar satellite.

Often criticized, often praised, often disappointed, but more often hopeful for full success of the nation's ballistic rocket and space exploration programs—of which he has been among the most-critical—Gen. Schriever, along with a free world, now waits and wonders.

The hybrid rocket poised at Cape Canaveral will be launched for a second try at circumnavigating the moon. The technological odds still are stacked overwhelmingly against success, but hopes and aspirations are not.

It seems fitting that m/r should paraphrase what Schriever said: . . . Out of the tremendous IRBM/ICBM effort will come a wealth of design information and hardware that will be useful for other things beyond that for which they were designed . . . Airframe, propulsion, and guidance subsystem developments and the data which will become available as ballistic missile test flights are made, will make possible a whole series of follow-on programs . . .

The second lunar probe attempt is just a small part. More ambitious programs will be the result.

Thor Engine Shipping Containers Developed

Air Logistics Corp. is now delivering newly designed plastic shipping containers for *Thor* IRBM rocket engines to North American Aviation at its Rocketdyne division plants at Canoga Park and Neosho.

Called Mobil-Tainers, the new shipping containers weigh 2,386 pounds, as compared to 6,436 pounds for the heavy pressurized steel cans formerly used. Cheaper to build, they are designed for use in Air Force planes, but they are also adaptable for use in field areas, since they can be towed by tractors or trucks.

At Neosho, Rocketdyne is now loading *Thor* engines into the Mobil-Tainers, trucking them to the Douglas plant at Tulsa (only airport in the Neosho vicinity able to handle Air Force C-124s), and flying them to Santa Monica.

Although the Mobil-Tainers were designed for complete engine systems for the *Thor,* they also will handle other engines in the missile program, or even combinations of engines. They are expected to be used widely in the near future.

Packaging-Handling Meet To Stress Space Logistics

The 4th Joint Annual Military-Industry Packaging and Handling Symposium, sponsored by the Department of the Navy, Office of Naval Material, will be held in Washington on September 30, October 1 and 2.

At the opening session, September 30, Dr. Gilford G. Quarles, chief scientist, U.S. Army Ordnance Missile Command, will talk on "The Challenge of Outer Space."

The afternoon session will be devoted to a panel discussion on "Space Logistics." The panel, under the chairmanship of H. Herman Koelle, ABMA, will have the following members:

Professor Hermann Oberth, ABMA
Dr. Ernst Stuhlinger, ABMA
Dr. Otto Schmitt, University of Minnesota
Dr. H. E. Newell, Jr., NRL
Capt. Charles F. Gell, ONR
Brig. Gen. D. D. Flickenger, ARDC
Mr. Robert D. Demoret, The Martin Co., Denver
Lt. Col. Rufus R. Hessberg, A.F. Missile Development Center, Holloman AFB
Mr. Vincent Blockley, North American Aviation, Inc., Inglewood
Mr. Charles L. Barker, Jr., ABMA

Space Flight Expert Boosts Solar Sailing

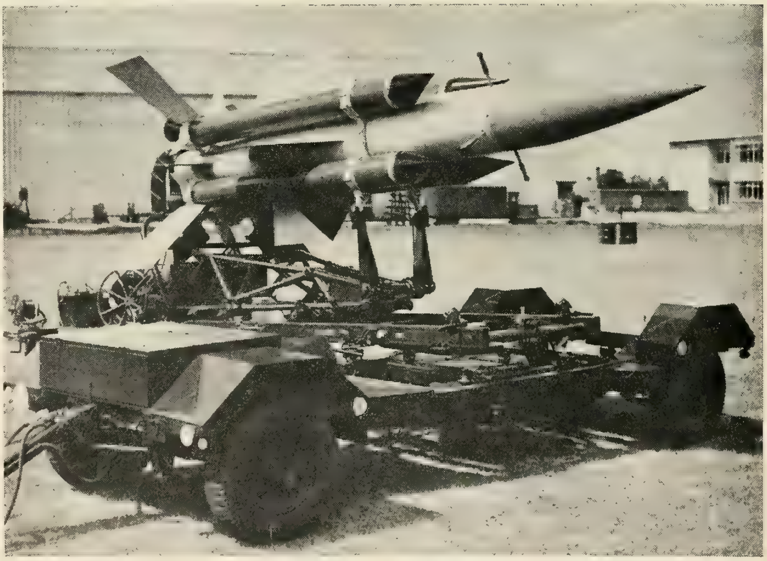
The "solar sailing" theory was given another boost recently by space flight expert Herb R. Lawrence, who predicted its use for interplanetary flight.

Lawrence, associate director of the Astrovehicles Laboratory of Space Technology Laboratories, likened the effect of the Sun's rays on spacecraft's aluminum-plated plastic "sails" to that of the wind on a sailing vessel.

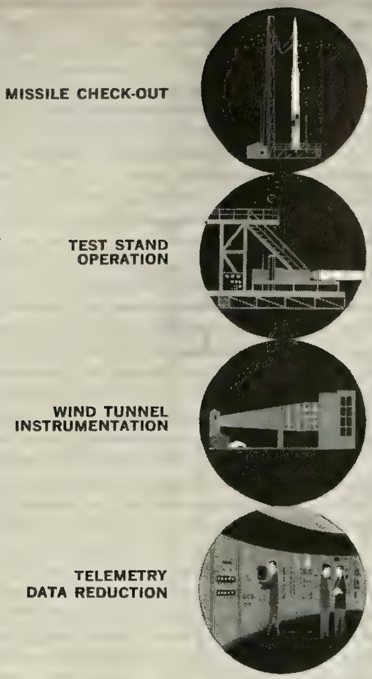
The lab executive, who described the solar propulsion method to the Los Angeles Chamber of Commerce Research Committee, estimated it would take 20-acre sails to run a space craft.

(The June 19th issue of MISSILE WEEK described the solar propulsion theories of Dr. George Gamow of George Washington University, who proposed a combination of solar and nuclear energy. Columbia University's Richard L. Garwin's theory of solar sailing was also discussed.)

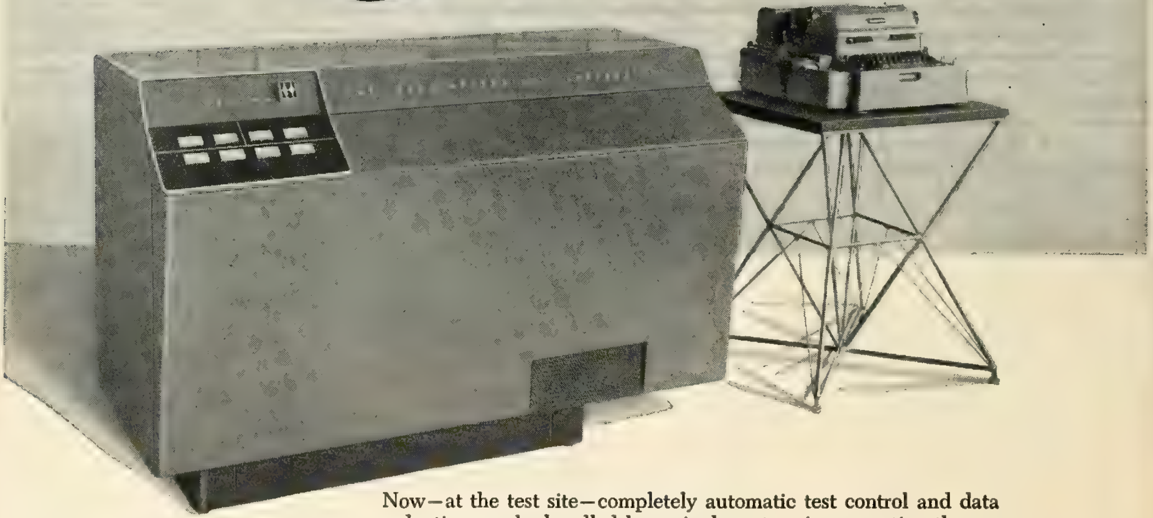
British Missile Entry



LATEST PHOTO of the de Havilland *Firestreak AAM.* It is shown fitted to a de Havilland Sea Vixen of the Royal Navy. The missile will also be stationed on the English Electric P.1 and the Gloster Javelin fighters of the Royal Air Force. *Firestreak's* infra-red guidance system, control power and fusing systems, propulsion motor and warhead are housed within a body tube 10 ft. 6 in. in length, with four wings and four control fins.



The RW-300 is the first digital computer for test control and data reduction



Now—at the test site—completely automatic test control and data reduction can be handled by a single system incorporating the Ramo-Wooldridge RW-300 Digital Control Computer. The new RW-300 can schedule and closely control test routines, and it can collect, analyze, and record test data.

The versatile RW-300 utilizes input data as feedback to modify control actions, thus substantially shortening many test routines. In addition, the RW-300 directly logs both instrument data and complex relationships among these data. Thus, test results are available immediately. The time-consuming task of processing raw data through a separate computer, often remote from the test facility, usually can be eliminated.

For technical information on automatic test control and data reduction with the RW-300 and with special digital systems which utilize solid-state components exclusively, write: Director of Marketing, The Thompson-Ramo-Wooldridge Products Company, P.O. Box 45607, Airport Station, Los Angeles 45, California, or call OSborne 5-4601.

THE THOMPSON-RAMO-WOOLDRIDGE PRODUCTS COMPANY

Did High-Energy Fuels Launch *Sputnik*?

A Hungarian publication has claimed that *Sputnik* III was launched with boron fuels and strongly indicates that the Soviet Union is giving top priority to development of a nuclear rocket engine.

The publication, HETFOI HIREK, said: "*Sputnik* III was propelled by a special fuel called boron, which is a compound consisting of boron and hydrogen. Other compounds are also being made in the Soviet Union through the aid of which the capacity of rockets can be increased by 40-50%."

(Russian scientists have denied that any high-energy fuels were used.)

"Soviet scientists are engaged intensively with the construction of rockets with a nuclear propulsion system. In this case they will install an atomic reactor into a furnace which is capable of substantially increasing the temperature of the propellant gas," the report said.

Also commenting on *Sputnik* III, HETFOI HIREK noted that "the shell of the Soviet satellite moons was made of a special aluminum alloy. In spots where the moon is expected to become hotter than the rest of the shell, due to the high degree of friction, a special protective coating is added. Part of *Sputnik* III was coated with magnesium, but silesium and a special coating of synthetic materials are also suitable."

"According to present concepts titanium and molybdenum will be used to protect the shell of rockets returning to earth . . . by supplying artificial moons with these protective coatings, they could be made suitable to return to earth the first experimental animals and maybe man himself from the first trip among the stars."

• **Bigger** *Sputniks?*—Another Iron Curtain publication, Berlin's DIE TECHNIK, said in an article by V. V. Dobronravov of the chair for Theoretical Mechanics at the Moscow Higher Technical School, that "it is possible to launch additional satellites of the same type as *Sputnik* III but larger and with greater launching velocities."

"It is quite possible that the first problem to be solved will be that of producing so-called guided or recoverable satellites. In such a case . . . the satellite must be oriented in relation to the earth . . . the flight of the satellite on its orbit must be in stages. This satellite must not rotate on its own axis."

In event that an alternative method is used (extension of control surfaces on reentry), "It is necessary that the landing on the earth be computed in such a way that it will not take place at some point X, but at a previously determined point within the Soviet Union. This problem is, without doubt, very complicated, but, in view of the present state of development of science and technology, automatic control, television engineering, radioelectronics and instrumentation, it can be solved in stages."

A vehicle of the *Sputnik* III type, only somewhat larger, can be converted into a space ship. Inside the vehicle, which is 5 to 6 meters long and 2.5 to 3 meters in diameter, space can be provided for one or two human fliers, and everything required for a ten-day trip to the moon and back can be installed. The required velocity of 11 km. per second is already a reality for Soviet science and technology."

Army Instructors Prepare For *Hawk* Training

The Army Ordnance guided Missile School is adding 83 instructors to its faculty in preparation for resident courses in the new *Hawk* surface-to-air missile system, Col. H. S. Newhall, commandant, has announced. The new courses will begin early in 1959.

The corps of new instructors, one of the largest groups ever to be added at one time to the Missile School teaching staff, has been training in special courses conducted by Raytheon and ARGMA here for the past six months.

Since finishing the courses, the group has been working in the New Missile Intelligence Branch of the Research and Curriculum Division of the Missile School to prepare texts, lectures, films, and training aids.

2,000 Watt Solar Units Feasible For Space Power

Solar energy converters capable of delivering up to 2,000 watts are now feasible as power supply sources for space stations and satellites, according to James D. McLean, president of the Laboratories Div. of Hoffman Electronics Corp.

McLean said such converters, utilizing silicon solar cells, offer man the best solution to date to the problem of generating continuous power in outer space.

The use of solar cells, the most practical means yet developed for converting light energy directly into electricity, was demonstrated in the Hoffman exhibit at the recent WESCON show in Los Angeles. The exhibit showed a model of a space satellite in which a bank of solar cells operated a miniature radio transmitter.

Already in use in the Navy's *Vanguard* satellite, the silicon solar cells are tiny wafers of highly purified silicon containing minute quantities of arsenic and diffused with boron. By means of these cells, it is possible to convert up to 10% of the light energy falling on a given area into usable electrical power.

To achieve the 2,000 watt output proposed, it will be necessary to expose some 20 square yards of solar cell area to the sun. In the 6.4-in. *Vanguard*, six clusters of 18 solar cells each are distributed over the satellite's skin to supply its radio voice with approximately 50 milliwatts (0.05 watt) of power.

The results of the Hoffman research on solar energy converters indicate that such a high-power converter can be developed, McLean said. Two proposed configurations for such a converter are a balloon, which would inflate after the vehicle reaches outer space, and a planar arrangement which could be unfolded from the launching vehicle after it is placed in orbit.

Hoffman recently completed four months of successful operation of a solar-powered radio repeater station atop Santiago Peak in Southern California. In this installation, tested for the U.S. Forest Service, a receiver-transmitter was powered by batteries kept in a charged-state by a large solar energy converter containing 500 cells.

Sub Environment Studied As Space Prototype

Some 200 of the world's leading authorities in environmental medicine met at the U.S. Naval Submarine Base in New London last week for the First International Symposium on the problem of environmental medicine under conditions of confinement in a true submersible, or a sealed space cabin.

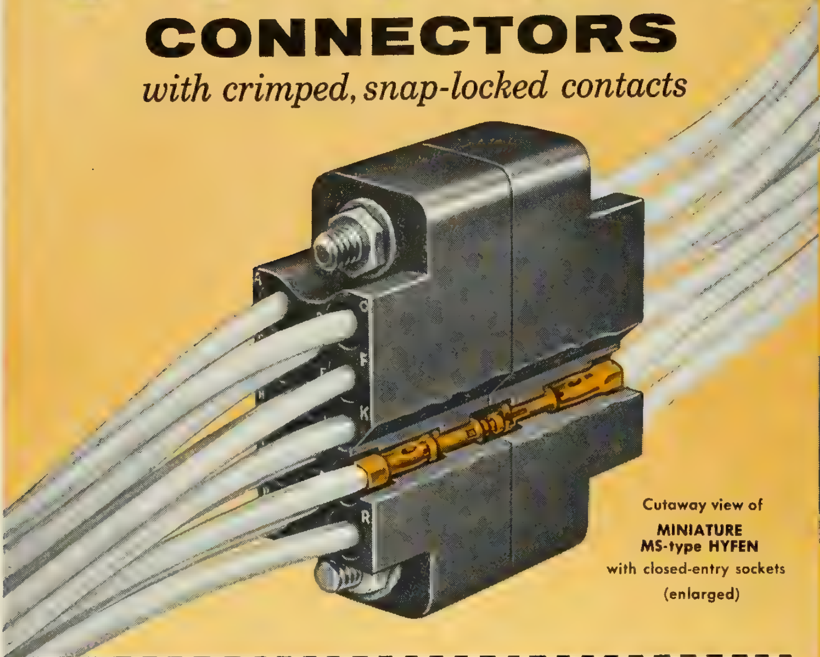
Captain Joseph Vogel, MCUSN, officer in charge of the Naval Medical Research Laboratory, host for the symposium, cautioned that science must determine whether prolonged exposure to such things as cooking odors and perspiration odors would be a hazard before man can safely venture into space or take long voyages on submarines.

The symposium was sponsored by the American Institute of Biological Sciences and supported by the Advanced Research Projects Agency of the Department of Defense. There were representatives from the United States, Brazil, France, Italy, Sweden, Germany, Japan, Great Britain, Switzerland and Canada.

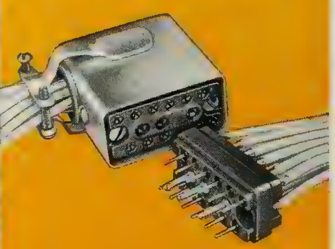
HYFEN T.M.

CONNECTORS

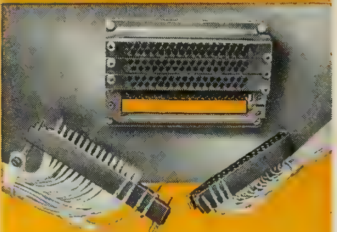
with crimped, snap-locked contacts



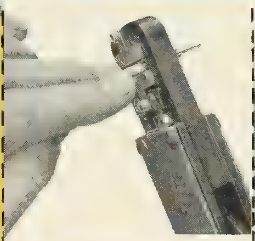
Cutaway view of
MINIATURE
MS-type HYFEN
with closed-entry sockets
(enlarged)



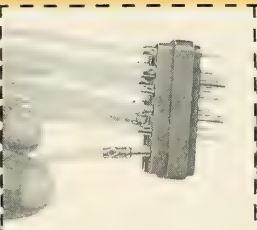
15 contact, multi-purpose connector. Mates with, or replaces existing solder connectors.



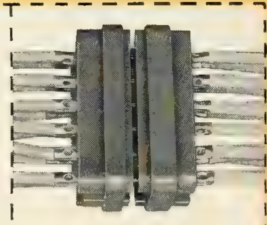
Feed-thru, modular design, multiple insert connector. 35 contact inserts, can be removed from frame for easy contact insertion or removal. 5 or 8 insert frames available.



CRIMP pins or sockets on wire



SNAP-LOCK contacts into plug or receptacle



MATE with HYFEN or equivalent solder types

AN-type HYFEN connector, showing HYFEN method adapted to round design.

SAVE WEIGHT, SPACE, TIME—Burndy's HYFEN method brings added Reliability and Versatility to the connector field, allowing the design of lighter and more compact equipment...saving space, weight and time. Pins and Sockets can be bench-installed on the wire and can be snap-locked in place even after the Plug and Receptacle have been mounted on the equipment.

Designed to replace or mate with virtually all existing connectors, including AN, MS, and other Miniature types, the HYFEN meets or exceeds MIL specs.

The HYFEN method ends the high rejection rate inherent with the use of solder ...especially important in today's continuing trend toward miniaturization.

HYFEN types illustrated are typical of those already supplied to the Industry by Burndy. HYFEN connectors are engineered to meet specific requirements. For other types and sizes, contact Burndy.

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missile business

A twilight-area is in the making for the missile business—divided about equally between heavy government spending for defense, and heavy pressure from the administration to hold spending to "reasonable, sensible" levels.

This condition is apparent when you compare DOD Secretary McElroy's statements to the American Legion (m/r Sept. 8, p. 17), with general predictions of improving business health coming out of Washington.

Almost every business barometer, public or private, looks for an upsurge in all lines, particularly in defense-based industries. The reason, of course, is the whopping $40-odd billion defense budget, plus the fact that the government is in a deficit-spending period—in itself an inflation-making factor.

McElroy's statement at Chicago—obviously a carefully-planned policy dictum—was aimed specifically at the missile field. He made it very clear that DOD will make every effort to hold down spending.

Spending hold-down will be on production contracts for new missiles and their supporting systems. Said McElroy: Moving into production too far ahead of research might result in "unusable duds–drugs on the weapons market, and a drag on defense resources."

Heavy emphasis will be on research and development—if at all. The Pentagon wants assurances that thorough testing and research is completed, before it will commit money to manufacture. Emphasis on research, by the way, makes a lot of the recent merger deals look smart, as companies seek to widen their R&D capabilities.

Further evidence of the spending dilemma is a statement last week by U.S. Budget Director Maurice H. Stans, who commented that "the incredible cost of new weapons will plague us as long as it is necessary to buy both today's and tomorrow's technology." Forecasting (for an American Bankers Association meeting) an $80 billion budget for Fiscal 1961, Stans added that the only way he could see to reduce spending was for a tight hold-down on "civilian" demands for government services.

Plant expansions include **Lockheed's Missile Systems Division's** huge 4,000-acre rocket engine test site, in the Santa Cruz mountains about 20 miles from Santa Cruz, Calif., where two separate complexes will test the Navy's *Polaris* engine, and various Air Force missile powerplants . . . **Horkey-Moore Associates** added space at its Torrance Calif., plant for testing missile high pressure pneumatic equipment, and specialized cleaning facilities for cleaning LOX components . . . **Miniature Precision Bearings, Inc.,** added 25,000 sq. ft. to its Keene, N.H. operation.

Callery Chemical Co. is pushing ahead on schedule in building what will be the first large-scale high energy fuel plant at Muskogee, Okla. Now 80% complete, the $38 million facility will produce liquid high energy fuels for the Navy.

Merger of Calidyne Co. of Winchester, Mass., and **Ling Electronics, Inc.** of Culver City, Calif., now makes Ling the biggest U.S. manufacturer of complete vibration testing systems. Under merger terms, all vibration testing systems and components will be sold and serviced in the East by Calidyne, in the West by Ling . . . **Chromalloy Corp.,** of New York City, has acquired **Propellex Chemical Corp.** of Edwardsville, Ill., thus adding Propellex know-how in solid propellants and cartridge-actuated devices, to its own patents on diffusion of chromium into primary metals.

contract awards

LAST MINUTE AWARDS

Technical Products Division of **Waste King Corp.,** Los Angeles, contracts totaling approximately $300,000 to manufacture heat exchangers and accessory equipment for the *Atlas, Thor* and *Jupiter* ballistic missiles . . .

Douglas Aircraft Co. awarded Research Laboratory of **Servomechanisms, Inc.** $101,672 for additional money for SMI's continued research into the fields of solid state physics . . .

Air Force awarded the Georgia Division of **Lockheed Aircraft Corporation** a contract to study power operated hydraulic and pneumatic systems to be used in space vehicles . . .

Corps of Engineers, U.S. Army, Jacksonville, Fla., issued a $483,517 contract to **R. E. Carson, Inc.,** St. Petersburg, Fla., for construction of *Snark* training facilities at Patrick AFB . . .

Koehler Aircraft Products Co., Dayton, Ohio, a subsidiary of the **New Britain Machine Co.,** received a contract to produce a series of special liquid oxygen valves for use in the USAF *Titan* ICBM.

Navy's Bureau of Ordnance awarded **Yardney Electric Corp.,** New York, $394,800 for the manufacture of its Silvercel silver-zinc batteries . . .

Temco Aircraft Corp., Dallas, Texas, was issued a contract for manufacture of the wings and elevons for the Army's *Hawk* surface-to-air missile.

AIR FORCE

By Cambridge Research Center, ARDC:

Texas A & M Research Foundation, College Station, Texas, received $90,000 for design and construction of mobile micrometeorological stations and study of the physics of the atmospheric boundary layer.

Pickard and Burns, Inc., Needham, Mass., received $50,600 for research and development on accurate methods for tracking and communicating with space vehicles.

Minneapolis-Honeywell Regulator Co., Boston, Mass., received $45,529 for recorder, reproducer, modular magnetic tape, seven channel instrumentation type.

NAVY

By Bureau of Aeronautics:

Reaction Motors Division of Thiokol Chemical Corp., Denville, New Jersey, received a letter contract for production of four internal combustion catapult powerplants.

. . . contracts

By Office of Naval Research:

George Washington University, Washington, D.C., received $25,740 for study in the field of mathematics.

University of California, Los Angeles, Calif., received $60,000 for research on the effects of high pressure and temperature on transformations and constitution of metal and inorganic solid systems.

University of Washington, Seattle, Wash., received $205,784 for research on a drifting station on the polar pack ice of the Arctic Ocean.

By Purchasing and Contracting Division, White Sand Missile Range, N. Mex.:

Reeves Soundcraft Corp., New York 22, N.Y., received $40,011 for magnetic tape.

By Ordnance District, Los Angeles:

Zenith Plastics Co., Gardena, Calif. received $50,286 for research and development on battle group weapon system projects.

California Institute of Technology, Pasadena, Calif. received $352,800 for engineering research and development regarding guided missiles, free rockets, materials and wind tunnel operation.

North American Aviation, Inc., Canoga Park, Calif. received $63,000 for rocket engines.

Solar Aircraft Co., San Diego, Calif. received $48,790 for gas turbine generator.

Douglas Aircraft Co., Inc., Santa Monica, Calif., received $27,766 for blue streak and emergency repair parts for the *Nike* system.

By Boston Ordnance District:

Brown University, Providence, R.I., received $35,352 for basic research on reactions of basic regents with aromatic substrates.

ARMY

By District Engineer, U.S. Army Engineer District:

Nabholz Construction Corp., Conway, Ark., received $56,980 for construction of receiver building satellite tracking station.

By Purchasing and Contracting Division; White Sands Missile Range:

Yuba Systems Division of Yuba Consolidated Industries Inc., San Carlos, Calif., received $138,860 for Purchasing and Contracting Div., White Sands Missile Range, N.M.

Douglas Aircraft Corp., Santa Monica, Calif., received a contract totaling $4,693,536 for the *Nike Hercules* program.

International Business Machines Corp., New York, was awarded a contract totaling $2,631,122 for automatic data processing equipment.

Republic Aviation Corp. received a contract for $1,318,825 for short range surveillance drone engines.

Douglas Centralizes Missile/Space Activities

A director of missiles and space systems engineering has been named by Douglas Aircraft Co., Inc., in a move to unify its control over all missile/space activity in the firm. The company has also realigned engineering division functions and the personnel assigned to them.

The new director is Elmer P. Wheaton, former chief missiles engineer. In his new position, he will report to Arthur E. Raymond, vice president-engineering.

R. L. Johnson will replace Wheaton as chief engineer of the Missiles and Space Systems Division.

In an effort to reflect the increasing importance of its Charlotte Division, which is producing missiles for the Army, A. D. Jamtass has been advanced from engineering manager to chief engineer.

In announcing the changes, Raymond said: "The scope and technical complexity of the company's activities have increased to the point where a more unified control of functions, regardless of geographical location, seemed desirable."

Beckman Instruments Form Semiconductor Subsidiary

Beckman Instruments Inc., Fullerton, Calif., has announced the formation of the Shockley Transistor Corp. as a subsidiary company. The subsidiary will expand development and manufacture of specialized components for electronic instruments, communications equipment and control systems.

Dr. William Shockley, Nobel prize winner and inventor of the junction transistor, has headed a group operating at Palo Alto since 1956 as the Shockley Semiconductor Laboratory of Beckman Instruments. Dr. Shockley has been named president of the new subsidiary corporation.

The Stanford Industrial Park facilities at Palo Alto have been expanded to permit a ten-fold increase in output of the Shockley four-layer transistor diode. Dr. Beckman, president of the parent firm, said this diode is capable of replacing five related components and is finding wide application in electronic digital computers, telephony and missile control systems.

X-7 Missile Breaks New Speed Record

A Lockheed X-7 ramjet missile has been flown in excess of four times the speed of sound to become the fastest air-breathing missile in the Free World, the Air Force announced. It broke the old record, also held by an X-7.

The record speed flight was so fast that heat generated by the supersonic velocity, coupled with normal engine heat, caused part of the ramjet to burn away.

Launched from a specially-modified B-50, the X-7 was air-dropped over the desert test range at the Air Force's Missile Development Center at Holloman AFB. A large booster rocketed the 37-ft.-long missile to a faster-than-sound speed where the ramjet took over. Within seconds the bird had accelerated to fantastic speed.

The engines flown are built by the Marquardt Aircraft Co., Van Nuys, Calif.

Summers Gets Contract For *Quail* Components

Summers Gyroscope Co. has received an additional contract in excess of $150,000 from McDonnell Aircraft Corp. of St. Louis for electronic components of a guidance subsystem for the GAM-72 project.

J. S. Warshauer, executive vice president, said this is the so-called *Quail* diversionary missile. He said the Summers Co. has been engaged in preliminary work on the *Quail* project in the last year, providing sensing instruments.

McDonnell is the Air Force prime contractor for development of the *Quail* weapons system.

NDA Moves Operations Into 63-Acre Facility

Nuclear Development Corp.,—a company that began operations 10 years ago with a staff of three employees—this week occupied its third major facility, a 63-acre research and development center in the Eastview section of Westchester County, N.Y.

The center, before year's end, will house research and development personnel and executive and administrative departments. When the move is completed, the company's present headquarters in White Plains, N.Y., will be devoted exclusively to engineering, experimental and fabrication activities. The company occupies other quarters at a 1,200-acre site at Pawling, N.Y., 40 miles to the north of White Plains.

The company has worked in the field of nuclear power and related activities. Particular emphasis has been on development of power reactors, using various materials — including heavy water and sodium—as moderators, to produce electrical power, and possibly to produce power that could be used for space applications.

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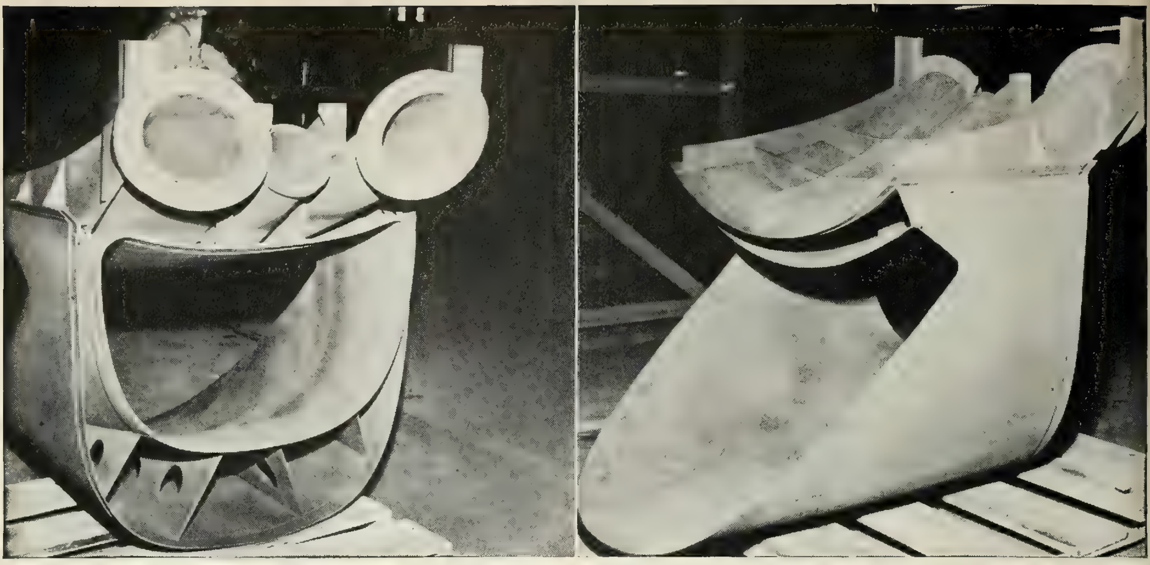


Engine air scoop casting made by R. H. Osbrink Mfg. Company, Los Angeles

MAGNESIUM "SUGAR SCOOP" HELPS REGULUS II BREATHE

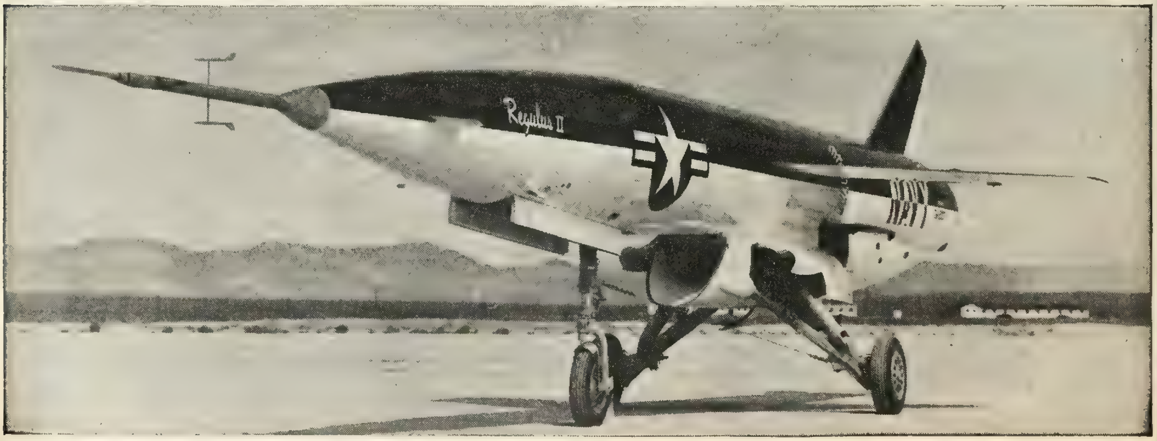
Huge thin-wall magnesium casting satisfies appetite for air

At supersonic speeds more than ten miles above the earth, Chance Vought Aircraft's Regulus II consumes enormous quantities of air through a 150 lb. magnesium casting.

This complex, close tolerance magnesium casting supplies air for the Regulus' powerful J-79 jet engine. It also provides ducting for boundary layer control and for air conditioning. Nominal thickness on walls and webs is 0.24 inch and the solid leading edge tapers to a 0.015 inch cast radius. Casting tolerance is + or −0.03 inch on dimensions up to 12 inches, with an additional + or −0.002 inch per inch on dimensions above that. That's real casting accuracy!

This air scoop is an excellent example of the versatility and usefulness of magnesium alloy castings in aircraft design. Thin-wall casting designs can be produced in magnesium to replace complicated, costly fabrications involving several production operations.

For more information about magnesium sand castings and their use in aircraft design, contact your nearest magnesium foundry or Dow sales office.



MAGNESIUM DESIGN, a 235-page handbook, discusses in detail: properties, structural design, product design including castings and mill products, fabrication and finishing. Large section of tables on properties, sizes, tolerances, etc. For your copy contact a Dow sales office or write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Department MA 1463L-1.

YOU CAN DEPEND ON DOW

propulsion engineering

by **Alfred J. Zaehringer**

More work on nitric acid propellant systems is being carried out at NOTS China Lake. Tetranitromethane, nitroethane, 2-nitropropane, and gem-dinitropropane are being burned with 99% nitric acid. Addition of small amounts of potassium nitrate or nitrogen tetroxide seems to smooth the "humps," or steps, in the propellant consumption rate curve.

Nitrogen tetroxide can now be produced directly from ammonia in the "Hoko" process, which can also produce high concentration nitric acid. High density N_2O_4 is being seriously considered as an immediate substitute for LOX in large missiles. Reason: relative ease in handling and use at normal temperatures. The oxidant can be stored.

Liquid hydrazine makes a good monopropellant, particularly for low-temperature auxiliary power units. Hydrazine itself is reported to have a performance comparable to cheaper ethylene oxide. Advantage of N_2H_4 over EtO is clean exhaust, however cost is still in dollars per pound. APU tests with monopropellant hydrazine are being carried out by Thompson Products and Sunstrand.

Propellant vaporization is a good parameter for determining rocket performance. Work by NACA at Lewis Flight Propulsion Lab indicates that the characteristic exhaust velocity is related to the percentage of oxidant and fuel vaporized and burned. A c* efficiency of 70-90% theoretical results when half the fuel is vaporized. Hydrogen fuels give the highest efficiencies.

Fluorine rocket motors of high thrust and long duration will be handled at a new test facility at Edwards Air Force Base, California. NACA, Rocketdyne, and Bell Aircraft have all fired low thrust, short duration fluorine propellant combinations. Though not mentioned, the Edwards fluorine facility might be able to handle 165,000-lb. thrust for up to 155 seconds. Elaborate decontamination techniques are proposed.

Perchloryl fluoride (PF) may be near for use as a rocket oxidant. Storable at room temperatures under slight pressure, liquid ClO_3F has a calculated I_{sp} of 270 seconds with hydrazine at 500 psia. This compares with the 320 seconds offered by fluorine and hydrazine. Safe PF is non-hypergolic with common materials such as clothing, wood, tissue, metals; however, it gives easy ignition and extremely smooth combustion with rocket fuels. Pennsalt is making PF available in tonnage quantities.

Double base propellant material, ethylene glycol dinitrate, is being researched at Hercules Powder Co., Allegany Ballistics Laboratory. Low pressure, flat flames of this material have been stabilized and may point to low operating pressure homogeneous propellants.

Solid potassium metal may be useful as an ion propellant. Low in cost, it offers higher performance than lithium or sodium but less performance than rubidium or cesium. Low availability of the latter two may prove serious stumbling blocks and give the nod to potassium.

Liquid ion propellants may be evolved from work done at New York University. Some alkali metals—particularly potassium and cesium—dissolve in ethylene glycol dimethyl ether to form electrically conducting solutions. Potassium is a medium ion rocket performer, while cesium is near tops for ions.

Ozone flames are stable in the 50-100% O_3 range, but are unstable for small temperature fluctuations at about 33.3%. Shell Development Co., Emeryville, Calif., has been studying ozone flame propagation.

Italian Edition of m/r To Start in October

Publication of MISSILES AND ROCKETS magazine in the Italian language will start on a monthly basis in October, following an agreement between American Aviation Publications and Dr. Giuseppe Stifani, publisher and editor of ALATA.

The Italian version of m/r will be entitled "MISSILI E RAZZI," and will be a monthly selection of articles which appear in the weekly editions of m/r. The only exclusions will be articles of a strictly local nature.

Editor of "MISSILI E RAZZI" will be Dr. Franco Fiorio, who will coordinate and screen the articles from Washington. Executive editor will be Dr. Glauco Partel.

Printing, editing and distribution will be from Milan, under the direction of the publisher, Dr. Giuseppe Stifani.

Soviet Deceit Cited In *Sputnik* Weights

There is increasing reason to believe that an intentional deception is being practiced by the USSR in regard to satellite weights. Western scientists who have consistently maintained that *Sputnik* II and *Sputnik* III were essentially the same have been given more ammunition by the Soviet Academy of Sciences.

In the JOURNAL of the Academy of Sciences of the USSR, Prof. G. V. Petrovich writes on the main problems in "cosmonautics" and cites progress in the development of rocket engines.

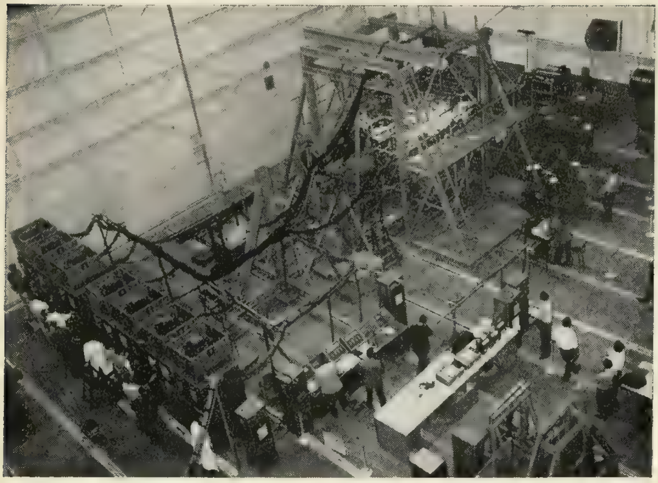
"Let us recall," he says "that *Sputnik* I weighed 83.6 kilograms; the weight of the scientific equipment, sources of power, and the experimental animal carried by *Sputnik* II was 508.3 kilograms; and the weight of *Sputnik* III was 1,327 kilograms."

This obvious reluctance to cite the total weight of *Sputnik* II has led to the conclusion that because a greater psychological gain would be made, the USSR deliberately understated the weight of its second satellite in order to make the third appear much larger. Actually, it is maintained, the two satellites weighed the same.

Prof. Petrovich also states in his article that "in the near future, the perigee of the trajectory of artificial satellites will be located at an altitude of more than 1000 km. (about 622 miles) above the earth's surface. As a result, the final stage of the carrier rocket and the satellite will not return to earth and may be used for the construction of stations outside the earth."

Just how literally the phrase "in the near future" is used could be the key to future Soviet space plans.

Missiles in the News



Bomarc—An Air force IM-99 *Bomarc* missile section undergoes simulated flight condition tests in Boeing Airplane Company's big new structural test laboratory. The section being tested is subjected to varying loads at elevated temperatures. *Bomarc,* rapidly approaching operational status, has made two remote flights from Cape Canaveral during the past month.

←

Nose Cone—A machine developed by Miller Research Laboratories for measuring physical properties which determine the dynamic characteristics of a ballistic nose cone in flight. The properties measured by the machine: moments of inertia, products of inertia, C. G. location, and weight. The equipment is also used to check performance of the guidance system and attitude.

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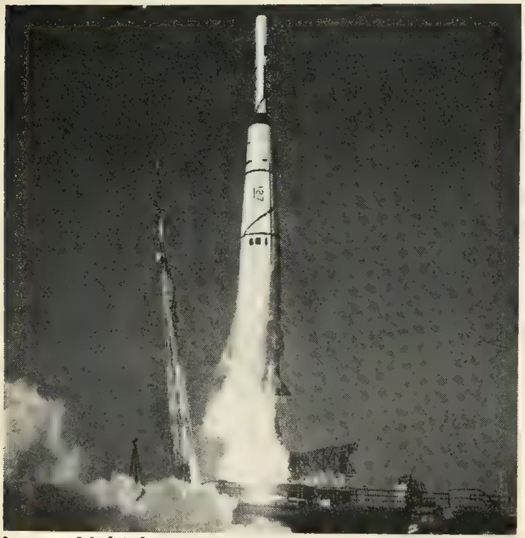

Lunar Vehicle—As m/r went to press, the second Air Force lunar probe attempt had not been scheduled. Take off of the ill-fated *Thor-Able* I vehicle on July 17 is shown as it left its pad for a 77-second flight.

Jupiter—The Army recently delivered to the Air Force the first tactical *Jupiter* Intermediate Range Ballistic Missile during a short ceremony at Redstone Arsenal, site of the Army Ballistic Missile Agency which developed the giant weapon system. The operational-type missile was handed over to the 864th Strategic Missile Squadron (IRBM-*Jupiter*), now in training at the Arsenal approximately one month ahead of schedule. Two research and development prototypes equipped with full-scale nose cones were successfully launched recently, and both cones were recovered in undamaged condition by the U.S. Navy.

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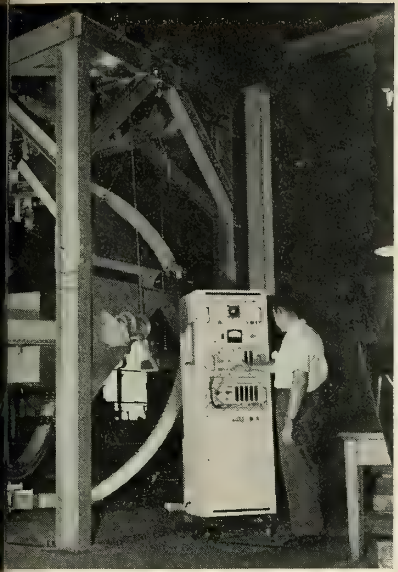

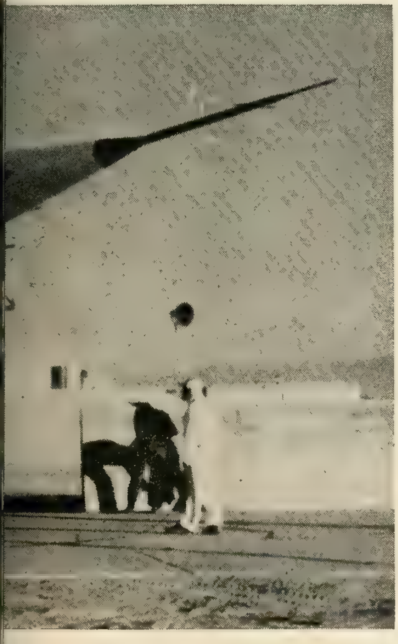

egulus II—This Navy missile is another rd being rushed to operational status in sts at Edwards AFB, California. Two long-nge proving flights were made last month om Point Mugu and Edwards to inland rgets. The missile is now being launched om a four-wheeled mobile launcher, which, th a tractor to pull it, can shift *Regulus* om one place to another via highway, fueled d "ready to go" at all times. The missile uld be launched in less than ten minutes ter shoot order. *Regulus* II is guided by her of two systems, the command system the inertial navigation system with assist. urrently, the missile is produced in two rsions—tactical and recoverable training.

Britain Struggles for Balance Between Aircraft and Missiles

an m/r staff report

FARNBOROUGH—The United Kingdom's air show here didn't give too much new information about Britain's missile program. The main concentration was on manned aircraft, specifically civil. Missiles were dealt with in vague terms.

Most British missiles are still in the developmental stage and security precautions are generally more stringent than in the U.S., with fewer performance figures either available or deducible.

Prospective foreign customers are reported to have been impressed with the performance figures released to them on a confidential basis, although discussion of delivery dates and costs were scrupulously avoided, due to the uncertain nature of British government backing of some missile projects.

The Defense "White Paper" of 1957 has left its mark upon the British aircraft/missile industry. The reduced work-potential inherent in the British government's decision to utilize missiles as much as possible, in lieu of manned aircraft, has left the industry with the alternative of switching to civil aircraft manufacture and striving for a greatly increased export market.

• **Fewer, but better?**—In contrast to the massive missile arsenal built by the United States, Great Britain has, whether for economy or out of wisdom, built her defenses on a lesser number of missiles, thus eliminating many of the overlapping functions appearing in the American programs.

A total of eight missiles is publicly recognized as comprising the entire British arsenal.

Six of these are tactical weapons: *Bloodhound; Short SXA-5; Seaslug; Firestreak; Vickers 891* and the *Thunderbird.* Seventh is the *Blue Streak,* a long-range strategic missile, and the last is the *Black Knight,* a ballistic missile believed used for re-entry tests connected with the *Blue Streak* program.

There has been a noticeable absence of the terms IRBM or ICBM in regard to the *Blue Streak,* so it is presumed that its range lies somewhere between the generally-accepted capabilities of these weapons, probably 2,500 to 3,000 miles.

Production of these eight weapons could not possibly supplant the production drop anticipated if the manned aircraft is entirely phased out.

Britain's Minister of Supply has estimated that the present 14 major airframe firms and five engine manufacturers will drop to three or four major airframe firms and two engine manufacturers within the next few years. Over the next five years it is also thought that Britain's aircraft/-missile industry will drop from the present employment level of 250,000 to about 150,000.

This situation will depend on three sets of circumstances: how well the industry can hold its own in the fiercely competitive export market for civil and tactical aircraft; the future requirements for manned aircraft (a subject just as hotly debated in Britain as in the U.S.); and the amount of money put into research and development.

• **Balance**—The choice of manned aircraft vs. missiles has been balanced a bit more since the Defense White Paper of 1957. It is more convincingly argued now that there will be further developments of manned craft beyond the present generation.

Sir Dermot Boyle, chief of Air Staff, argued that missiles, due to their inflexibility, simplify the defense problem for the enemy, who can concentrate his countermeasure efforts against unmanned weapons. Manned aircraft, Sir Dermot declares, will be kept in service "until we are satisfied that its successor can do the job."

A standoff missile developed for the V-series of strategic bombers now in use with RAF has been developed by A. V. Roe & Co., which is developing still another better version of the weapon. Supplementing this air-to-surface weapon system will be the U.S. *Thor* IRBM, a 1,500-mile weapon which will probably be replaced by Britain's own *Blue Streak.*

The *Blue Streak,* with a 2,500 to 3,000 mile range, is Britain's first long-range ballistic missile, and is being developed by deHavilland Propellers. Rolls Royce has the propulsion system contract; Sperry is responsible for guidance. Systems development is underway at Hatfield, Hertfordshire.

The weapon will have a liquid propellant rocket engine, probably quite similar to American models, since Rolls Royce has a cooperative agreement with Rocketdyne in the United States. Light weight is being achieved by structural techniques, and it is believed that the missile's structure will be pressurized to gain rigidity.

U.S. Proposes Plan to UN For "Peaceful Use" of Space

by Frank G. McGuire

In what State Department spokesmen described as a "political move to get the United Nations to set up a body to explore the peaceful uses of outer space," the United States has handed the UN a proposal to insure peace in space.

The President's proposal was given to Secretary-General Daj Hammarskjold by the U.S. Ambassador to the U.N., Henry Cabot Lodge. Lodge had previously commented on the plan in a speech delivered to an American Legion convention in Chicago, but as m/r went to press, there were still no real details available.

The United States' proposal asks the U.N. to include the plan, entitled "Program for International Cooperation in the Field of Outer Space," on the agenda of the 13th General Assembly session beginning September 16.

An explanatory memo accompanying the letter asked that the assembly declare itself "on the separability of the peaceful uses of outer space from disarmament; support the principal of the peaceful utilization of outer space and come out in favor of setting up "appropriate international machinery" to deal with outer space questions. Apparently, this last item is the core of the American proposal.

The door was left open for Soviet participation in the plan. Lodge pointed out that "we trust our proposal will get the support of other nations and that, together, we can move forward toward this goal with the courage and vision of our early pioneers."

The American ambassador added that "We will continue our efforts to reach agreements, consistent with our national security, which will increase the prospects that outer space will not be used for military purposes."

Lodge said the U.N. should consider what projects can be undertaken and what sort of organization it can set up for the nations of the world to work together in such explorations. "The United States wants to see outer space used so as to enrich the lives of all people who live on this planet," he added.

"Progress in this field would be faster, cheaper and more efficient if all the nations concerned agreed to work together," he said, adding that all scientists in the world have something to contribute, but that all of us have much to lose if outer space is subjected to national rivalries. "No matter what happens, study and exploration of outer space will go on and will take man where no human being has been before. This will affect every man, woman and child in the world," he declared.

Tests Show Conditioning For Space Feasible

Recent high-altitude tests indicate that man can be partially "space-conditioned."

In an experiment at Fairplay, Colo., six volunteers, after strenuous mountain-climbing conditioning, were able to take a 55,000-foot-altitude simulation. Before the test none could go higher than 49,000 feet.

The project, arranged by the School of Aviation Medicine, covered 40 days during which volunteers ascended and descended 14,260-foot Mt. Evans.

Although a final analysis of the test is not complete, Dr. Balke has come to some tentative conclusions: Potential space men should be between the ages of 30 and 45, and must be in top physical condition.

The reason for the 30-year age minimum, according to Dr. Balke: "It will take a space man that long to get all the necessary training and education."

Troops Test Redstone

ARTILLERY, 1958—Troops of the 40th Army Field Artillery Group *(Redstone)* give the giant missile a horizontal checkout before pulling it into vertical position for firing at the White Sands Missile Range. The first simulated firings of *Redstone* were made with a dummy warhead, though the missile can carry either conventional or atomic warhead.

de Havilland Announces Liquid Propelled Engine

Development of the *Double Spectre* liquid propellant rocket has been announced by de Havilland Engine Co. The *Double Spectre* has been undergoing intensive testing as a missile and interceptor main propulsion unit since 1957.

The engine comprises a fixed-thrust *Spectre* D.Spe.4 mounted above a variable-thrust *Spectre* D.Spe.5, both units operating on their normal propellent combination of high-test hydrogen peroxide and kerosene.

Several hundred runs of the *Double Spectre* have been successfully performed, involving single and double unit firings equivalent to many hours of rocket operation.

The upper and lower *Spectres*, essentially independent units, are carried on a common tubular frame with tubing connections. The vertical arrangement of the units was chosen to avoid the yaw thrust component which would be incurred in a horizontal alignment when one engine is either shut-down or operated at a partial-thrust setting. The angular relationship of the individual units is arranged so that thrust lines intersect at the center of gravity.

The *Double Spectre* does not require an external source of power for its operation. To run the engine, the lower rocket is started first. This unit, a variable-thrust *Spectre*, is equipped with a spherical starter bowl fed with nitrogen from the small pressure bottle on the starboard side. With the lower unit operating, a small bleed of hydrogen peroxide is fed across to energize the pump-turbine of the upper *Spectre*. The complete starting procedure occupies a matter of a few seconds.

At start, both *Spectres* may be brought instantaneously up to full thrust and then either unit may be shut-down. The lower unit can also be fired initially.

Thus there is a controlled variable-thrust range between the idling-output of the lower unit through to its maximum thrust; or alternatively, the output may be variable over the upper portion of the thrust range from approximately half thrust, with the lower unit idling and the upper unit at its fixed maximum thrust.

Double Spectre dimensions: overall length, 58.6 in.; maximum height, 37.5 in.; maximum width, 36.6 in. No data on performance has been released.

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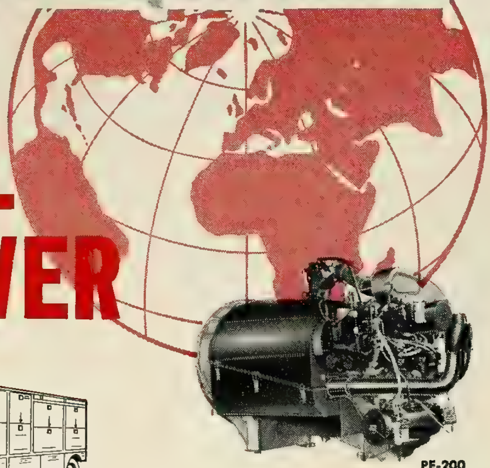

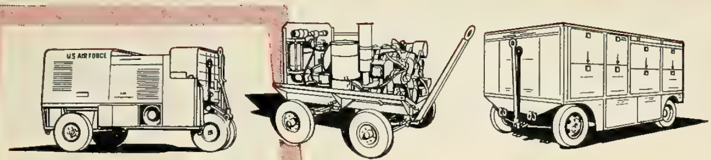

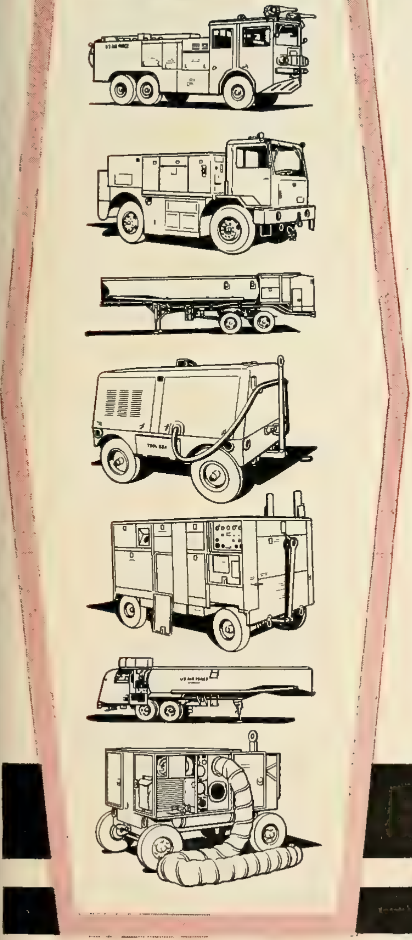

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Northrop-Arma: New Missile Giant?

by Raymond M. Nolan

Rumors continued strong this week in Washington concerning the projected merger of Northrop Aircraft and American Bosch Arma Corp. While no details of the financial mechanics were available, some indication of the structure of the projected new organization could be reported.

The new organization will retain W. C. Collins of Northrop as chairman of the board, and Charles W. Perelle of Arma will become president. Organization of the individual companies will remain largely unchanged, but one Arma official says that the name of the new organization will be completely changed.

Some speculation has occurred about the compatability of Northrop's Nortronics Division and Arma, but when the companies were queried, neither thought that any competition would arise from the merger. Even though the primary mission of each of the organizations is guidance, the nature of the mission in either case means that it is more likely that a complementary situation will result.

Arma has three major projects at present: the all-inertial *Titan* guidance system; the same system for future use on the *Atlas;* and tail turrets for the B-52 bomber.

Nortronics has several defence-supported projects, among which are: stellar-guidance for the *Snark;* airframes, loaders and launchers for the *Hawk.*

• **How it works**—It is not too difficult to determine how each of these projects will fit with others in the future.

One of the company-financed projects being pursued by Nortronics is a sub-miniature stable platform, something Arma could certainly use on its inertial guidance program where the stable platform is encased in a housing that is probably heavier than the whole unit which Nortronics is developing.

Another area is computer circuitry. Arma currently has a guidance computer in its system which weighs 180 lbs. A five-year program is expected to reduce this to 60, and then 20 pounds respectively. However, Nortronics has been looking into this situation for some time and now has one of the only lightweight, all transistorized digital computers in existence.

One of the tricks Nortronics is using which might very well find its way into the Arma system is encasing transistors in vacuum bottles and then electronically cooling them to eliminate one of the really serious hot spots in an electronic system.

Another area might be the Cueball system developed by Nortronics. This is an angle of attack and sideslip indicator to determine exact vehicle attitude and transmit intelligence to the guidance system so that objects such as nosecones can achieve reentry at the proper angle to insure minimum heating and preturbation.

• **Coast to Coast**—Of course, overriding all this is the significant fact that this merger brings together R&D and production facilities on both coasts, capable of executing any mission in connection with a major missile program. Arma has the proven capability and excellent productive capacity which any successful program needs, and Northrop has unlimited research and production facilities in most of the areas where Arma is lacking such as airframe and ground support.

Some of the company-financed, experimental projects now in progress at Northrop include such diverse items as space power sources, infrared devices, and advanced optical applications.

Of further note is the qualification program which Arma has initiated with components it plans to use in its systems. Many thousands of semi-conductors, for example, are always in test in the extensive quality control laboratory of Arma. Arma, in addition, has been subjecting many of its components to radiation at Brookhaven National Laboratories to determine the effects of an atomic warhead or power source on guidance systems.

NRL Reports *Explorer* IV Tracking Transmitter Dead

The U.S. Naval Research Laboratory announces that the 108 MC transmitter in the Army's *Explorer* IV was last heard at 7:15 p.m. EDT on September 8, by the Navy's Minitrack Station at Lima, Peru.

Prior to that time, signals were becoming progressively weaker, indicating that failure of the transmitter was near.

The satellite is still transmitting on the telemetry channel at a frequency of 108.003 MC.

The Army satellite was launched on July 26, 1958.

First *Thor* IRBM Arrives in Britain

Reports that the first *Thor* IRBM has been delivered in Great Britain have been confirmed both by the U.S. Air Force and the British Air Ministry.

Air Force said the *Thor* deployment is "going forward as planned," with one full RAF squadron to be equipped by the end of December.

First of 60 Britainbound *Thors* was airlifted two weeks ago by the giant Douglas-built C-124 transport, but by last week, had not yet been transferred to the RAF.

Four *Thor* squadrons, with 15 missiles each, are planned for eastern and northern England.

One specific criticism of the 65-foot liquid-propelled *Thor* is that its above-ground site leaves it more vulnerable to attack while Britain's *Blue Streak* will be deployed in less exposed concrete pits. However, *Blue Streak* is still in the development stage and it is expected it will be several years before it is operational.

To date 22 *Thors* have been tested at Cape Canaveral, with 13 rated "good" by the Air Force; five "failures."

Prime contractor for *Thor* is Douglas Aircraft Co., Inc.

Meanwhile first British trainees have arrived for *Thor* indoctrination at Douglas Aircraft Co., Inc.'s Tucson facility.

Martin Contract Confirms Earlier M/R Prediction

A Navy production contract for $2,438,449 has been given the Martin Company's Orlando, Florida Division for the air-to-surface guided missile *Bullpup.* This confirms increased production as mentioned in m/r (p. 13, Sept. 1). No information regarding the number of units included in the contract was in the official release. M/R had said production would be increased from 30 missiles per month to 600.

Bullpup is a tractical guided missile designed for use in glide and dive bombing by carrier-based Navy aircraft and shore-based Marine planes. Martin made the original research and development tests flights of *Bullpup.*

In one early test a Navy pilot who launched the missile in his first try hit a four-inch square target two miles away. A non-nuclear weapon, *Bullpup* is designed for use against comparatively small targets—pillboxes, tanks, truck convoys, bridges, railroad tracks, and the like.

Bullpup is 11 feet long and weighs about 565 pounds. It operates in the visual range of the pilot.

Douglas, Hughes, FMC Form *Minuteman* Team

Douglas Aircraft Co., Hughes Aircraft Co. and Food Machinery and Chemical Corp. have jointly submitted a bid in support of their proposal for the assembly and testing of the Air Force *Minuteman* ICBM missile. The *Minuteman,* a solid propellant land-based missile, is destined to be a top member of the second generation of ballistic missiles, succeeding those now being tested.

As major subcontractors to Douglas, Hughes would be responsible for electronics and FMC for ground handling equipment of the system. To provide major policy direction to the program, Douglas has formed what will be known as the *Minuteman* Assembly and Test Policy Board.

The board is comprised of President Donald W. Douglas, Jr. as chairman; A. E. Raymond, vice president-Engineering, Douglas Aircraft; L. A. Hyland, vice president and general manager, Hughes Aircraft Co.; J. M. Hait, executive vice president and director of Engineering, Food Machinery and Chemical; E. P. Wheaton, Douglas director of missiles and space systems engineering; Kenneth B. Bingham, general manager, Douglas Aircraft *Minuteman* Division.

The *Minuteman* Board will meet at least twice a month to conduct complete program reviews and establish major program policy direction.

To provide direct program management, Douglas has also formed a separate division to be known as the *Minuteman* Assembly and Test Division. It is constituted on the same basis as the rest of the Douglas Divisions and will be assigned sole responsibility for management of the *Minuteman* Assembly and Test Program under guidance of the Policy Board.

Douglas currently has the major responsibility for the airframe, systems integration and for supporting ground equipment for the *Thor* IRBM. Hughes Aircraft's missile experience dates back to 1946 when they began studies of missile techniques that culminated in the *Falcon* series of air-to-air missiles. As prime contractor of *Falcon,* Hughes has developed the *Gar-1D.* Radar seeking version and the *Gar-2A* infrared seeker. Also under development is the *Gar-9* version of the *Falcon.* This will be a guided missile that carries an atomic warhead.

Food Machinery and Chemical Corp., long a leader in the manufacture of diversified machinery and equipment, has designed and built more types of military-standardized tracked vehicles than any other firm in America.

Rocket-Boosted Radiosonde Probes Weather

Convair Division, General Dynamics Corporation, is currently developing a rocket-boosted radiosonde for ARDC's Wright Air Development Center, Dayton, Ohio.

The radiosonde will gather weather data by probing the atmosphere 29 miles above the earth, and will be used by Air Weather Service forecasters as a meteorological sensing device and as a research tool for studying and recording high altitude weather phenomena.

Designed to be launched from a weather reconnaissance plane at an altitude of 40,000 feet, the radiosonde will travel into the upper atmospheric regions, carrying with it instruments to record temperature, humidity, pressure, and other meteorological information.

• **How it works**—The accompanying drawings illustrate the two sequences involved in the operation of the radiosonde, the launching cycle, and the component separation cycle.

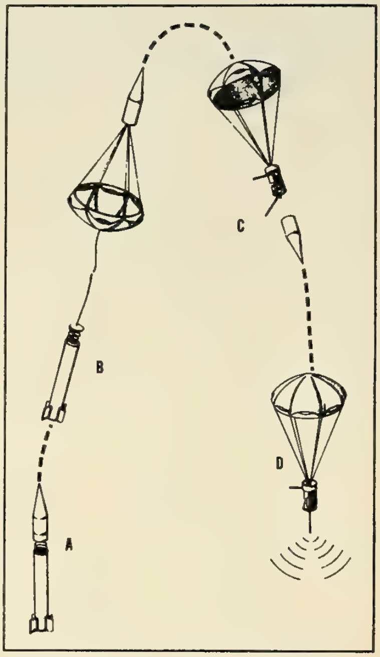
In the launching sequence, the reconnaissance plane drops a nine foot long, 194-pound cylindrical container (1) in which is packed a launching tube housing the rocket and the radiosonde. After the unit clears the plane, a deceleration parachute is deployed (2) to stabilize and slow its descent.

Several seconds later, a small charge blows the outer casing free, the drag chute is separated (3), and a cluster of three parachutes opens above the rocket launching tube (4). The three chutes, grouped together with lanyards, form a triangle—with an opening in the center—to steady the launcher in vertical position (5).

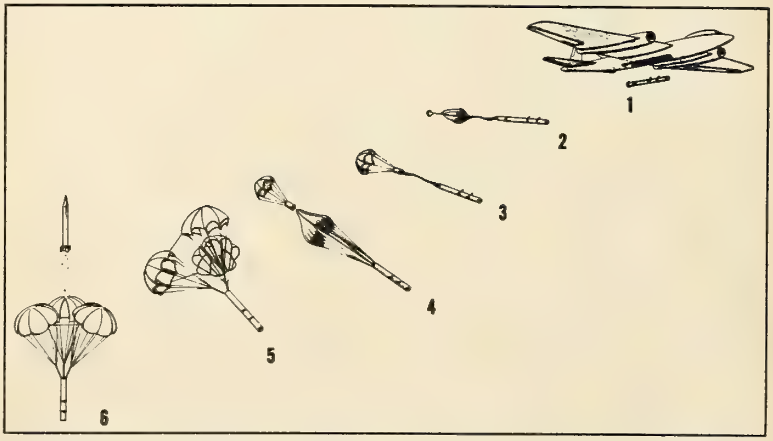
After stabilization, a pre-set timer launches the rocket which blasts up through the center of the chutes.

At the peak of the trajectory, the rocket ejects the nose cone containing the radiosonde, a stabilizing parachute is deploying (a and b), and the radiosonde is thrown free (c).

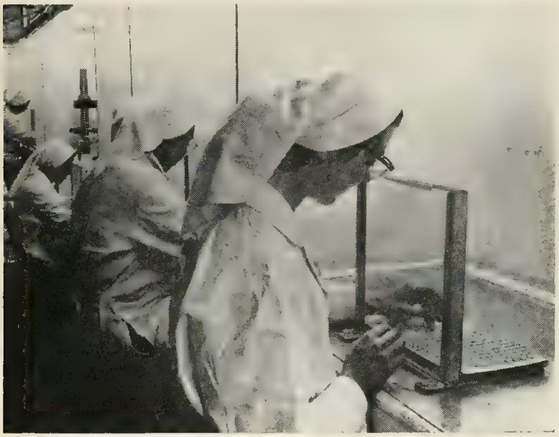
Antennas are erected, and, as the vehicle makes its descent to earth, the gathered data is telemetered back to the airplane for later evaluation (d).

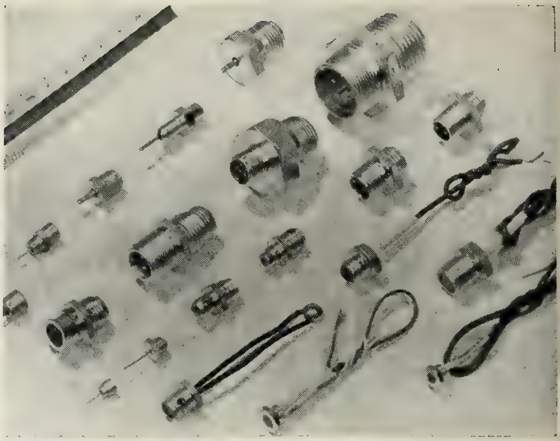


Component Separation Sequence, after ejection of rocket nose cone.



Rocket-Boosted Radiosonde Launching Sequence, after drop from reconnaissance airplane.





Out of precise operations like these . . . come fine precision products like these, as . . .

McCormick Selph Diversifies For Growth

by Richard Van Osten

DIVERSIFICATION seems to be a current keyword in the missile industry. Acquisitions, mergers and other corporate machinations are announced every day—all for the broadening of an organization's capabilities.

Across the fence, there are companies with a product line of specialties which have such broad application that it becomes a problem to stay flexible within their respective fields, deliberately avoiding diversification. It's not a simple thing to stay in your own backyard, yet continually expand a product line for greater application and increased sales.

McCormick Selph Associates, Hollister, Calif., is a good example of the case in point.

The company's bread and butter is an extensive line of explosive ordnance products: explosive bolts; pressure cartridges; gas generators; solid and liquid-propellant ignitors; initiators and high-pressure electrical connectors for use in guided missiles; ordnance rockets and aircraft.

With one or more of its products on practically every missile and rocket manufactured in this country, including prototypes and development models, the company's principal concern is to limit its activities to components.

"When we see how some of our products are used," says Don McCormick, president and general manager, "it's a great temptation to build equipment for, or to improve, other fields."

• **Basic hardware**—Diversification is not overlooked, but it is applied to the company's own product line. Over 600 items are produced by McCormick Selph. This includes special modifications to standard line items. As a result, there may be as many as 14 different versions of a single item—mostly changes in explosive charges or electrical requirements.

The basis of the company's seven years of existence is its initiator. This has led to the large line mentioned above, and a monthly gross of $130,000, with 95% for the missile field.

Initiators are broken down into three types: electric primers, squibs and detonators, all of which may be actuated electrically by a battery, condenser discharge or a generator source. The units consist of an electrical connector, case, installation provisions as required, and an internally heat-sensitive primary explosive. The primer types are loaded to produce a brisant, hot flash. The squib types produce a hot flash and a little brisance, while the detonator carries supplementary explosive loads to produce high-velocity shock waves.

From this basic hardware, McCormick has developed solid and liquid-propellant igniters for the missile manufacturers. These are complete ignition systems consisting of either a percussion or electric initiator and a deflagrating material of a pyrotechnic or solid-propellant type. For some type of liquid propellants, the igniter consists of a liquid catalyst and a pressure cartridge. All the company's igniter designs are controlled by the parameters of the motor design and the propellant to be ignited.

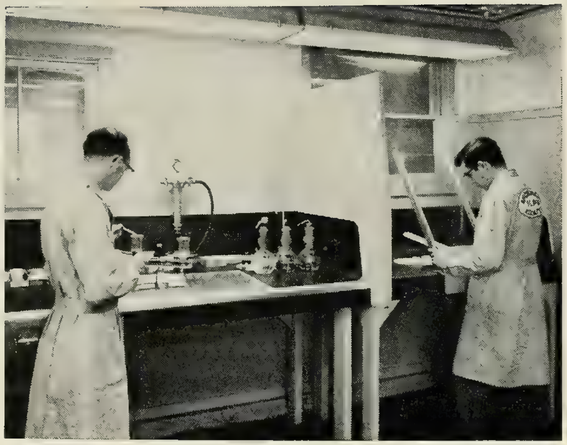
• **Plus items**—Other items that develop from the initiator include the pressure cartridges, which use either a primer or squib-type initiator, and a pressure-producing propellant. The standard pressure-producing time for these items is one-half second and pressures as high as 70,000 psi can be produced. A second product is a large line of explosive bolts with either an integral or separate explosive.

Still another line is offered—high-pressure electrical terminals for introducing circuitry into pressurized chambers. Capable of withstanding 60,000 psi, the terminals have been used in a solid-rocket engine at 4,500 psi for six minutes with a propellant-flame temperature of 3,300°F.

Newest addition to the McCormick Selph line are gas generators-small, solid-propellant rocket engines consisting of propellant, initiator, igniter, pressure-regulating nozzle, canister, initiation connector and gas outlet fitting. Activation for the generators may be produced mechanically or electrically and the energy requirements tailored for most any system.

In this field, the company has recently introduced a service of cool-gas generators, which produce gas with controllable densities and temperatures as low as −25°F. A typical application of the gas generator is for pressurization of the hydraulic accumulator in

WELDING BRIDGE WIRES requires special tools, almost surgical cleanliness and care.



LABORATORY CHECK is a must for many of the tiny parts required for missile components.

one highly-touted Navy missile.

- **The unknowns**—Although McCormick Selph has some of their devices on the *Jupiter-C, Sidewinder, Atlas, Titan, Falcon, Snark, Regulus, Terrier* and *Polaris,* company officials say that it is sometimes difficult to "sell" explosives.

"People are frightened every time you mention the word," they say, "but explosives and pyrotechnics are no different from anything else, if you have knowledge of their characteristics."

Many unknown factors exist in propellants for which the company has supplied igniters, particularly in burning rates and temperatures, as related to the balance of the system. The problem of classification also enters the picture, and McCormick is often asked to produce a specific type of igniter without the benefit of knowing just exactly what the system is or what the propellant characteristics are.

However, McCormick does not feel they are alone in this area, as many of their customers have propellants in the development stage and are not yet completely certain themselves about all the things they are doing.

The company has done a considerable amount of research and development in formulating its products. One very successful program was to increase the burning rate of ordinary, dependable black powder, which seemed to be completely unsatisfactory at altitudes over 30,000 ft. This was accomplished by a coating process using zirconium, and the new formula is now being used at altitudes in excess of 100,000 ft.

Stress is placed on reliability and quality control. The former has become less and less of a problem, but the latter requires constant emphasis because of the precise timing, electrical and charge requirements.

Atlas Set for Full-Range Test

One of the two *Atlas* ICBM's currently undergoing final checkout within their gantrys at Cape Canaveral, Fla., may soon be slated for a full range test-shot.

According to a program spokesman, a full scale firing at a range of about 5,500 miles is expected within the next three or four weeks. The second successful launching of a full-powered bird on Aug. 28 was indicative of the exceptional progress being made in the accelerated flight program.

A weld in the outlet elbow of the main liquid oxygen line (extending from tank to turbine) held up the last firing approximately five days. The elbow, which collapsed during a pre-flight pressure check, was removed, repaired and replaced within record time.

The latest *Atlas* test-shot reached only a fraction of its design range, due to overloading with instrumentation and telemetry gear. It was pointed out that although a successful full range shot may be realized within the next month, an operational ICBM with the required accuracy characteristics is two to three years away.

The August 28 firing was guided to a pre-determined target area by a radio-command guidance system developed at General Electric's Missile Guidance Section.

R. L. Shetler, section manager, termed the launch a "giant stride forward". Referring to the *Atlas* guidance system, Shetler said: "In addition to greater on-target accuracy, command guidance allows continuous ground control during the powered flight phase. The ICBM's course can be continuously corrected during early flight. If signals indicate the missile has strayed from its programmed flight pattern, an immediate automatic correction is made to put the missile back on the prescribed course."

The *Atlas* radio command guidance has been reported to be virtually jam-proof. Coated anti-jam filters which reject all outside interferences, are of a highly selective space, time and frequency nature.

The radio signals control *Atlas* only during the first five minutes (total engine burning time) of approximately thirty minutes flight time.

The radio command is also utilized for arming of the warhead. A ground base computer determines whether or not the missile is following its planned trajectory, and if the warhead will fall in the predetermined target area. The radio arming signal is not given until computer indicates this trajectory is being followed.

Russian Scientific Works Available in English

Approximately 60,000 pages a year of key Soviet scientific and technical journals are being made available in English translation to United States scientists and engineers by the National Science Foundation.

In releasing a compilation of the translations, NSF indicated that there are now 53 English editions of Russian journals, four series of abstracts, and four series of partial translations of important Soviet journals.

missile people in the news

Honors

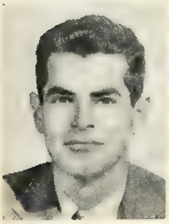
Max A. Pape, senior research engineer for Lockheed Missile Systems Division, Sunnyvale, Calif., was elected as an officer of the New Interamerican University Alumni Association. He will be secretary-treasurer of the Association.

Membership in the American Rocket Society has been extended to **Maj. Ben I. Funk**, USAF, head of the Ballistic Missiles Office of Air Materiel Command at Inglewood, Calif.

Dr. Anthony J. Cacioppo, human factors specialist for Goodyear Aircraft Corp., has been appointed to the U.S. Air Force-sponsored Committee on Life Sciences, a division of the National Academy of Sciences.

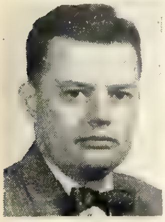
Dr. Knox Millsaps, chief scientist at the Air Force Missile Development Center, Holloman Air Force Base, N.M., has been granted a special Honorable Mention Award by the William A. Jump Memorial Foundation.

Sales



Saul Padwo was named assistant to the vice-president of Yardney Electric Corp. Padwo, who was manager of sales and products application at M. Ten Bosch, will work with **Martin E. Kagan,** vice president of the firm, concentrating on sales in the commercial markets.

Paul Sturm has taken over the post of manager of Military Marketing for Motorola's Military Electronics Division. He was previously manager of the Washington office for Military Marketing.



Dale S. Samuelson was appointed sales manager of the Instrumentation Division of the Applied Science Corp. of Princeton (ASCOP). He will direct the nationwide sales program for the Division's line of data handling systems and components. Samuelson joined ASCOP in March 1956 as a sales engineer, and has been Southwestern District sales manager for the past year. He opened the company's first sales and service office in Dallas, Texas.

Robert A. Bailey is now director of marketing for the Industrial Products Division of International Telephone and Telegraph Corp. He joins ITT from Norden-Ketay Corp., where he was marketing manager for the Data Systems Division and Western Division.

Engineering

J. V. Howell, Jr. has joined Packard-Bell Computer Corp. as a project engineer. His first assignment will be to direct the development of a missile impact prediction system for Cooke Air Force Base, under a contract awarded Packard Bell Electronics by Aerojet-General Corp., Azusa.

John A. Rhoads has become associated with Packard-Bell Electronics Corp. as director of engineering in The Technical Products Division. Rhoads replaces **Dr. George J. Mueller,** who will remain at Packard-Bell temporarily as a consultant.

Karl H. Epple has been appointed director of engineering, and **Edward W. McLaren** director of manufacturing for the Heli-Coil Corp., Danbury, Conn.

Frederick P. Huston has been named to the position of chief methods engineer with Tube Reducing Corp., Wallington, N. J. **Scott N. Randall** is new chief product engineer.

Top Brass

Bruce L. Mims, formerly chief engineer of the Barden Corp., has been elected vice president—engineering.

Rear Adm. Earl E. Stone, USN, who retired from active Naval Service in January, 1958, has become a director of HOLEX Inc., producers of packaged explosive power, Hollister, Calif. He was formerly superintendent in command of the United States Naval Postgraduate School at Monterey and served as Director of Naval Communications in the Navy Department, Washington, D. C.

Three vice presidents and an assistant comptroller have been appointed at ITT Laboratories, U.S. research division of International Telephone and Telegraph Corp. Assistant vice presidents: **Ivan Sattem, John E. Kahelin, J. Eugene Bower; Russell C. Irish** is the assistant comptroller.

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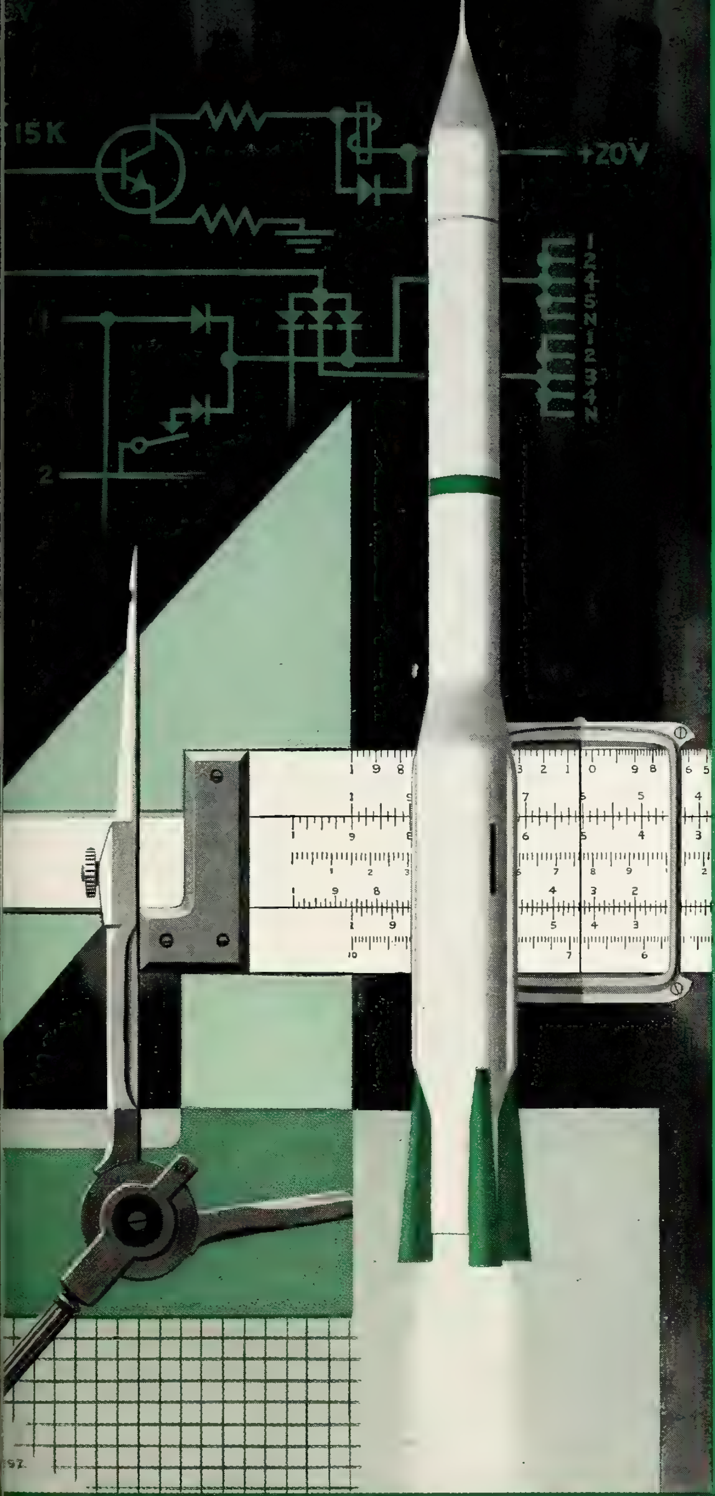
advertiser's index

American Airlines, Inc.	23
American Potash & Chemical Corp.	16
Avco Mfg. Corp., Crosley Div.	35
Burndy Corp.	20
Continental Motors Corp. ...	29
Diversey Engineering Co.	4
Dow Chemical Co., The	24
English Electric Co., Ltd., The	3
Food Machinery & Chemical Corp.	13
L. O. F. Glass Fibers Co. ...	6
Lithium Corp. of America, Inc.	36
Ryan Aeronautical Co.	8
Sequoia Wire Co.	2
Thompson-Ramo-Wooldridge Products, Inc., The	18



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Crosley creative systems management insures speed and discipline during every phase of every project—no matter how complex.

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This combination of creativity and technical know-how has already proved itself in many defense projects: in Crosley's MD-9 fire control system, in its *Falcon* air-to-air missile components, in its research and development of the *Volscan* air traffic control system, in fuzing mortars, shells and missiles.

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For further information, write to: Vice President, Defense Products Marketing, Crosley Division, Avco Manufacturing Corporation, Cincinnati 25, Ohio.

Avco / Crosley

Lithium and the lighter alloys...

The lighter side of metallurgy is characterized by lithium-bearing alloys, particularly for advanced scientific applications.
The exceedingly important properties accruing to these special alloys by the inclusion of lithium, and described here, further indicate the unique role of lithium metal in making laboratory probabilities commercial possibilities.

DOW THE DOW CHEMICAL COMPANY

Ballistics is making good use of the ductility, toughness, and very low densities achieved by alloying lithium with magnesium and aluminum. In gages under 1" it has proved to be effective as armor plate, absorbing energy and preventing fragmentation. More important, 1" of magnesium-lithium-aluminum alloy can replace ¼" steel—yet is ⅓ lighter. Dow Chemical's interest in the cubic structure of magnesium-lithium alloy led to modifying the basic binary system by the addition of a third element—aluminum—producing a very high strength-to-weight ratio.

ALCOA ALUMINUM ALUMINUM COMPANY OF AMERICA

Jet aircraft traveling 1600 mph at operating altitudes develop "skin" temperatures of approximately 350° F. Conventional aluminum alloys employed in aircraft construction begin to lose physical properties in the 250-350° F. range, limiting their usefulness to speeds below 1300 mph. Stainless steel and titanium are alternate solutions but add immensely to cost and weight of airframe structures. Alcoa's new X2020 aircraft alloy utilizes the rare-earth element lithium to push ahead the thermal barrier in supersonic aircraft by about 100° F. Not only does it serve to maintain aluminum's strength at high temperatures, but this aluminum-lithium alloy is 3% lighter and has 8% greater modulus of elasticity which adds to structural stiffness.

MC General Plate Division METALS & CONTROLS CORPORATION

Lithium is also used as a deoxidizer in the gold melting process to prevent the contamination of molten gold by oxygen in the pouring operation. Metals & Controls found lithium metal a stronger deoxidizer than phosphorus, previously used. Polishing, formerly difficult due to particles resulting from the oxide of phosphorus, was simplified.

LCA

Cooperative research on special lithium alloys is available to interested parties under our joint working agreement with Brooks & Perkins, Incorporated of Detroit, fabricators of magnesium and other light metals. Letterhead inquiries should be addressed to our Technical Service—Sales Department.

LITHIUM CORPORATION
OF AMERICA, INC.
1104 TITLE INSURANCE BUILDING
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SEPTEMBER 22, 1958

missiles and rockets

INCLUDING MISSILE ELECTRONICS

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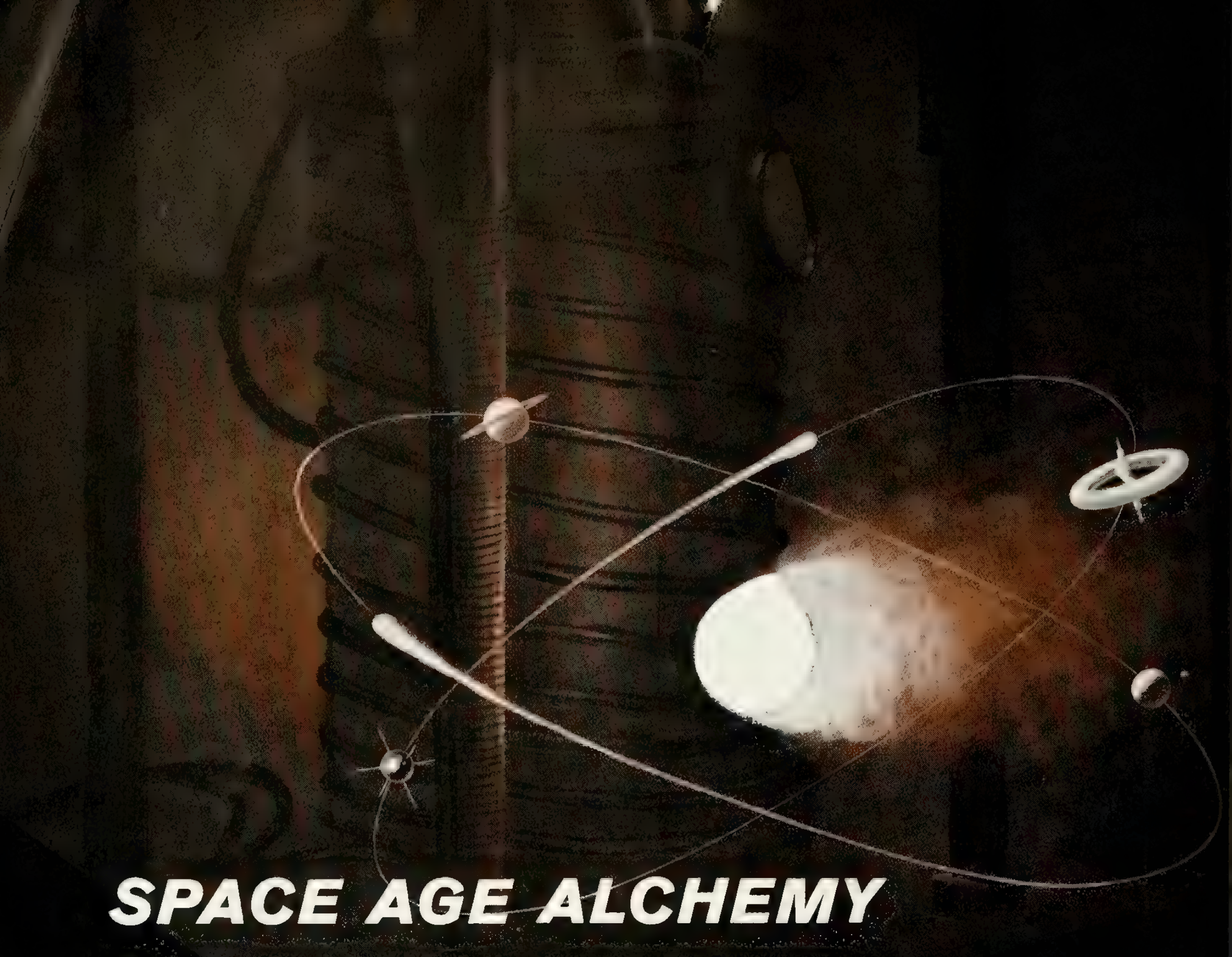
AN AMERICAN AVIATION PUBLICATION



SPACE AGE ALCHEMY

New materials, capable of withstanding extremely high temperatures and encompassing properties that meet specific requirements are now being created at Servomechanisms' Research Laboratory. SMI's research has been in the field of solid state physics, wherein the study of basic atomic and molecular properties of matter has resulted in materials that can actually be designed to accomplish specific tasks. The challenging space age will depend heavily upon such techniques.

Major scientific break-throughs in the "State of the Art" have already resulted in new materials capable of operating at 500°C and new investigations indicate that this upper limit may be extended to 1000°C.

The above illustration pictures an experimental hot press, developed by SMI, for basic investigations into these new materials. The press subjects various compounds to 3,600°C and 6,000 PSI in a vacuum or inert gas.

These new advances are providing positive support to the ever-increasing requirements of the Department of Defense. The expanding Research Laboratory facilities are ready to assist you in your advanced scientific programs.

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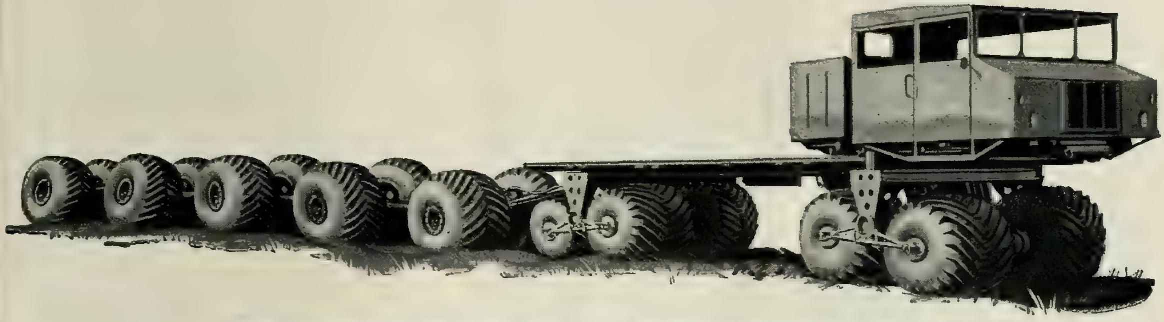
The products of SMI are available in Canada and throughout the world through Servomechanisms (Canada) Limited, Toronto 15, Ontario.

5,000 GALLONS OF FUEL— ROLLING IN UNIQUE TIRE-LIKE CONTAINERS CALLED ROLLI-TANKER—ARE CAPABLE OF FOLLOWING AMAZING "GO-ANYWHERE" TIRES INTO HERETOFORE **IMPASSABLE** AREAS!

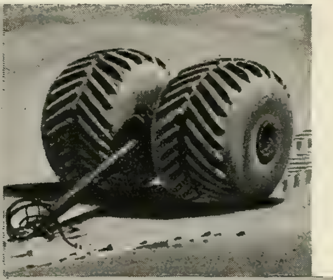


ROLLI-TANKER TERRA-TIRE

LET YOUR PROJECT UTILIZE THIS AMAZING

mobility

Wide Ground Contact Area of the axle-driven Terra-Tire by Goodyear can traverse sand, mud, marshland, snow and roughest going without failing. Principle lends "go-anywhere" mobility to vehicles—and liquids.



Filled with fuel, these Rolli-Tanker units—mounted in pairs and available in sizes with filled capacities of from 140 to 500 gallons each—can travel most anywhere! Tow-bar units can be equipped with own filling, emptying, braking systems.

Float fuel ashore—the Rolli-Tanker makes it no problem to get bulk fuel or liquid supplies ashore. No costly pumping or long-line hoses needed with this new Goodyear advance.

Fuel ready, where needed—this unique system is easily the most foolproof answer to needs for mobile fuel supplies. An advanced Goodyear development for national defense.

For details contact: Goodyear, Aviation Products Division, Dept. Akron 16, Ohio.

GOODYEAR

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...THE TRULY REUSABLE FITTING FOR FLUOROFLEX®-T HOSE

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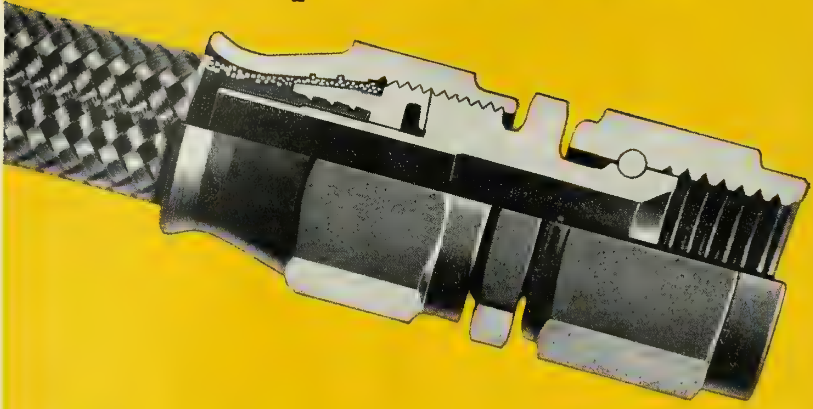

Positively leakproof

- **A** Threaded lockring grips braid tightly; buried, it's tamper-proof.
- **B** Before tightening—nipple about to contact coned disk of lockring.
- **1** Tightened . . . spring action of coned disk locks threads in compression
- **2** Male threads are securely wedged against flanks of female thread
- **3** Radial displacement of coned disk presses rim against socket wall.

Superior design gives this reusable fitting the same iron-clad safety and reliability as the service-proved Resistoflex factory-swaged fitting. The unique coned disk lockring provides a triple lock when nipple is tightened... the fitting *cannot* leak, *cannot* blow-off.

Seal-Lock fittings are specially designed for fluorocarbon hose. Their reliability is assured by the company with the greatest experience in fluorocarbon hose production. They're CAA approved. Send for bulletin giving full data. RESISTOFLEX CORPORATION, Roseland, N. J. Dept. 141.

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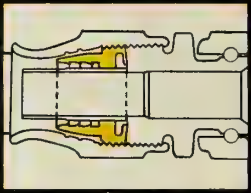
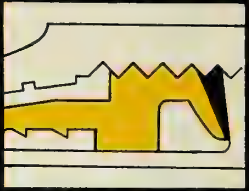
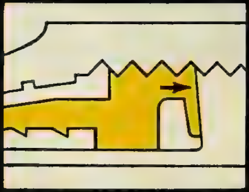


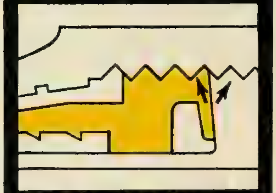
A. Threaded Lockring



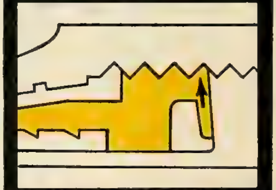
B. Lockring unloaded



1. Lock washer action



2. Lock nut action



3. Thread lock action

Originators of high temperature fluorocarbon hose assemblies

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SEPTEMBER 22, 1958

VOL. 4, NO. 12

missiles and rockets

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Whither Vanguard

Naval Research Laboratory's future in space research will be decided before the end of the next five *Vanguard* satellite orbiting attempts. Political or public opinion pressure against continuation of the ill-fated program beyond the end of the International Geophysical Year will undoubtedly sway the decision.

Vanguard has been something of a political football since the Navy underbid the other services on the project away back in 1953. At the moment it seems to be something of a political liability, too, with neither ARPA nor NASA, both new and vulnerable agencies, exactly fighting to get it.

Vanguard, despite the fact that its record in launching satellites is meager, actually has a valiant scientific accomplishment record, as pointed out elsewhere in this issue. President Eisenhower, on advice of his scientific advisors reportedly is receptive to transferring Vanguard to NASA, with ARPA happily concurring and NASA regarding such a move with mixed emotions.

The question is—in the eyes of ARPA and NASA officials—whether *Vanguard* should continue to be looked upon as strictly a non-military program and logically should fall under NASA's Congressionally-dictated role of "peaceful scientific space exploration," or whether it should be continued for military purposes only in field assigned by the President such as space communications, navigation, weather, etc.

Some $50 million of ARPA funds are slated to be spent annually for the next three years in continuing and expanding the Hagen space team. However, any continuation would not be the original *Vanguard* program per se, but would see drastic modifications both in management and actual hardware, with only proven capabilities of the original program being utilized for future space vehicles. This is good.

It seems to us that the NRL team—a *military* institution with the task of perfecting *military* research for the benefit of tomorrow's advanced U.S. Navy—should continue to work for ARPA. If this were the case, the NRL will continue to function as one, undiluted unit designed to work for progress in military space flight. This is the kind of progress this country needs. From the military advances will come the engineering breakthroughs which in turn will advance our "civil" astronautics goals.

contents

NEWS

Army Gets Nod on 1.5-million lb. *Jupiter* Cluster 13
AFA Presents Top Speakers at Dallas Meeting 14
Space Scientists Use Sun for Moon Power Station ... 15
Third Inflatable Satellite Hits 160,000—Fails 18

FEATURES

Here is the *Vanguard* Record 22
Cavitation Detector Aids Missile Fuel Stability 29
Missile Guidelines 30
Does U.S. Lag on Ozone Fuel Use? 33

COLUMNS

World Astronautics 37
Astrionics 41
Space Age 51
Missile Business 55
Soviet Affairs 81

DEPARTMENTS

Industry Countdown 9
Washington Countdown 11
Missile Electronic News 39
New Missile Products 46
Letters 52
When and Where 57
Book Reviews 58

"THE COVER"

Now that both the Air Force and Army have received the nod to obtain engines of a million pounds or more of thrust (see p. 13), the spacemen envisioned on the cover by a Japanese-born artist are not nearly so fanciful a prospect. With engines such as the million-pounder authorized for the Air Force, and the 1.5 million pounder for the Army, payloads necessary to put a space station into orbit come close to possibility.

STAIRWAY TO SPACE

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The steps by which man approaches the Space Age consist, in major part, of advances in control technology.

Within the technological family of Telecomputing is the combination of *skills, facilities, products, services,* and *creative experience* to solve control problems of the Space Age, and to offer superior solutions to today's industrial and military control problems.

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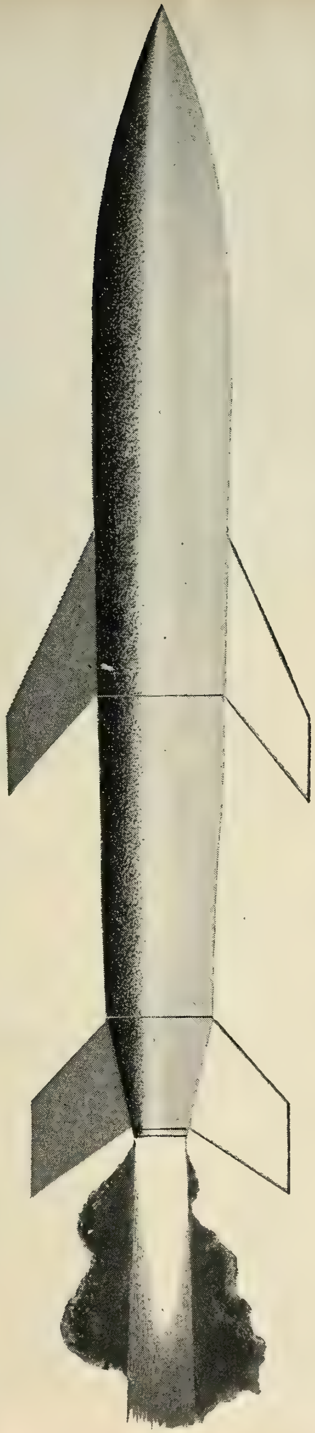

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4

3

2

1 SOURCE...

for complete weapon systems

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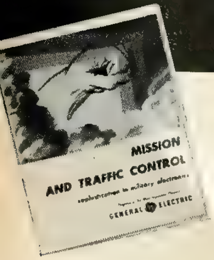

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industry countdown

Contractors have been warned about releasing information pertaining to "contracts, operations or facilities," even though it may be asked on certain government questionnaires. Recent advice from DOD says: "Questionnaires submitted by or under sponsorship of the Executive branch should be complied with when there is evidence that the request has been approved by the Budget Bureau."

Dissension over Nixon's tax program as outlined at Harvard has been in evidence in Washington, even among staunch Republicans. They oppose his ideas of cutting taxes for upper income brackets with the idea of thus stimulating investment. "Cut consumer taxes so people can buy what we are already making," they say. Nixon's probable position in the 1960 race has made his proposals more significant.

The "Buy American" policy for the U.S. Forces abroad has not deterred Nord-Aviation, a French firm, from producing and selling over 15,000 missiles. The sales have been made to Canada, Sweden, Germany, Italy, Israel, and even some to the U.S. Largest item is the SS 10 antitank missile and its successors, the 11 and 12.

A new research organization, Analytic Services Inc., has been formed as a non-profit organization. The firm has taken over the former quarters of AMF's defense products group in Alexandria, Va. The group was formed to perform contract research on problems related to national security.

Reorganizations and mergers show increasing corporate interest in missile business. The Weatherhead Co. has formed a new Aviation and Missile Group comprised of three plants in various sections of the country. Firewel Co., Inc. has organized its new Space Technology Department to supplement its Aeronautical Equipment Department. Electrosnap Corp.'s new Astromatic Division will develop and produce electromechanical subsystems and components. CBS-Hytron has consolidated its mechanical and electronic equipment design, development and production facilities at Newburyport, Mass.

An Employe Pension plan has been approved by Temco Aircraft Corp. The plan is the last phase necessary to include all of the firm's employees in a retirement system, and affects about 4500 personnel not previously covered. It becomes effective October 1. A professional placement office has been opened by RCA for scientists and engineers of senior level in the New York City area.

Air Force Requirements from industry have been broken down into approximate areas of expenditures. The $10 billion annual figure has been subdivided into $4 billion for hardware to support the operating AF and $6 for new weapons and equipment. About 4,000 prime contractors are involved, over 600 of which are in New York state.

A personnel shift at Food Machinery and Chemical Co. has resulted in a new boss for Grand Central Rocket Co. Charles E. Bartley, formerly president of GCR, has been named coordinator of FMC's rocket propellant activities. He is succeeded at GCR by Dr. Cledo Brunetti, who has been elected a vice president. GCR is a subsidiary of Petro-Tex Chemical Corp., which is jointly owned by FMC and Tennessee Gas Transmission Co. In announcing the switch, FMC cites its "growing interest and activities" in the rocket propellant field.

Marquardt Aircraft Co. will change the name of Associated Missile Products Co., which it recently acquired from AMF. The firm will henceforth be known as the Pomona Division of Marquardt.

Aerojet's underwater activities have led to increasing speculation on the state of rocket-propelled-torpedo art. The Aerojet-Azusa plant considers its recent $19.3 million contract for an antisubmarine torpedo to be "one of the most important projects ever to hit the plant."

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Operating speed: 0.3 inches per second at 3300 lbs. load on 28 volts DC.
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Features:
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washington countdown

The "E" ring of the Pentagon—that's where the big brass sits—is busier than a county courthouse in a Georgia Primary. Reason: Reorganization is picking up speed—and nobody knows which assistant service secretaries will be eliminated.

The worry goes down the line, too, to R&D organizations of all three services. Their problem: Who will be the new Director, Research and Engineering. The appointment is due within about two weeks.

You can stop using the term NACA (for National Advisory Committee for Aeronautics), and start using NASA (for National Aeronautics and Space Agency) about Oct. 1. That's the date when NASA Administrator T. Keith Glennan is expected to announce his organization is ready to absorb NACA.

Excess funds for ***Polaris,*** voted by Congress, will be kept on tap, though it's not certain the money will be spent this year. How fast the money will be spent depends on research and development progress.

Army and Air Force have been ordered to stop low-rating each other's anti-aircraft missiles—AF's *Bomarc* and Army's *Nike-Hercules*. Cease fire orders came from Secretary McElroy, who added that both missiles will stay in the arsenal.

The right missile has been picked for display at Air Force Association's convention at Dallas this week (see also p. 14). The *Atlas,* to be on display outside the convention hall, last week completed its third successful test over a 3,000 mile range. The first full-range test (about 6,000 miles) may be made in the next few weeks.

A weather observation satellite has been developed by Army signal research and development laboratory, says October ARMY INFORMATION DIGEST. But Signal Corps adds, privately, that there is no scheduled launching program.

ARPA isn't just a space agency. Look at two other research areas ARPA's working on: anti-submarine warfare, and night fighting for ground troops. Agency chiefs hasten to add that they're studying proposals and are open for suggestions, pending arrival of technically competent people.

That night-fighting scheme, by the way, will be worth watching. It is said to entail a lot more than equipping troops with proper glasses.

Contrary to strong Washington rumors, USAF is interested in sponsoring activities of junior rocketeer groups. A regulation to this effect is currently being drafted in Pentagon. The program is primarily concerned with safety factors, and one requirement for USAF cooperation is that interested groups must be properly organized. Main problem seems to circle around getting personnel and space to handle the young rocketeers.

The British are talking about launching large satellites. Ministry of Supply is continuing its check into whether such rockets as *Blue Streak* and *Black Knight* may be used for launching such vehicles. There are some problem areas—money being one. Some experts are already complaining that modification of these rockets for satellite launchings would be an expensive diversion of the nation's military effort.

No cancellation is in sight for *Atlas* or *Titan,* despite the emphasis on which system will be slated for specific tasks. Says AF Maj. Gen. Charles McCorkle, assistant chief of staff for guided missiles: "Liquids still look good for space exploration—liquid ballistic missiles will not be phased out completely."

AMF isn't pulling out of the electronics business—despite the Washington rumors to that effect. The rumors are based on the fact that last year, AMF discontinued operations of its Boston facilities, now has sold its Westcoast firm, AMPCO (see p. 9). But with its Greenwich Engineering Lab, and facilities in Chicago and Alexandria, Va., AMF is still in.

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Million-Pound Thrust Engines Will Be *Jupiter* Clusters

DOD Authorizes N.A. Rocketdyne Power Plant; Clusters Will Be Interim Answer, Pending Single-Chamber Unit

By Donald E. Perry

WASHINGTON—The Army Ordnance Missile Command at Huntsville and Rocketdyne Division of North American Aviation have been authorized by the Defense Department to cluster modified *Jupiter* engines to provide a 1.5 million-pound thrust vehicle within one year. This confirms a story appearing in m/r (September 8, p. 13).

The action came after reportedly "high level" decisions between Advanced Research Projects Agency and the soon-to-be National Aeronautics and Space Administration. According to an ARPA spokesman it was mutually decided that ARPA will have cognizance over the Army's engineering program to cluster the *Jupiters*, while NASA will administer Air Force and Rocketdyne efforts in development of a one million pound thrust single chamber engine. However, a query to NASA Administrator T. Keith Glennan by m/r brought the comment that no "final decisions had been made in the area of high-thrust engines."

The single-chamber development, for which Rocketdyne has a $2 million Air Force contract, is considered to be some four to five years away from flight test. ARPA wants the interim *Jupiter* development within one year for the initial purpose of placing a 24-hour satellite in orbit some 22,300 miles above the earth's equator. The satellite would be used for communications relay in the high frequency spectrum.

• **Possibilities**—However, a communications relay satellite for the clustered *Jupiters* is but one possible application. It could also be used for interplanetary probes and a manned satellite. ARPA declined comment on these possible uses, saying only that "there are no specific programs for utilizing the clustered *Jupiter* boosters," and the program is geared strictly for "satellite maneuverability and recoverability." One prototype vehicle is planned for the initial program.

The clustered *Jupiter* program is expected to cost nearly $20 million. Intial contract to Rocketdyne is also $2 million—in the same bracket as the single chamber development.

Defense Department has said that a single-chamber engine in the one million pound thrust bracket could orbit a 20,000 lb. satellite or provide an interplanetary probe weight of 5,000 lb. Such an engine would be about 17 feet high and would have a diameter of about eight feet for the exit area.

ARPA said it decided on the *Jupiter* plan because of the proven "extreme reliability" of the Rocketdyne engine (unofficially estimated at 80 percent) and clustering is the only method feasible to give "early availability" of large boosters necessary for space exploration objectives.

• **Clusters**—"Seven or eight" *Jupiters* will be clustered, according to ARPA, which foresees no "major" engineering problems. The Army's Ballistic Missile Agency at Huntsville will work with Rocketdyne in engineering the clusters and fabricating a new frame. A static engine test stand at Redstone Arsenal, capable of handling twin 500,000 pound thrust engines, will be modified slightly for the program. Army reportedly as of September 12 had ordered nine additional Rocketdyne engines, although some may be slated for *Explorer* programs in probing the radiation belt.

The Rocketdyne engine used in *Jupiter* is rated at approximately 150,000 lb. of thrust. Use of hydene as a fuel, based on experience with the *Redstone* rocket, probably would up performance by 15 percent, giving a thrust of possibly 175,000 lb. Eight engines then would provide thrust in the neighborhood of 1,400,000 lb.

ARPA acknowledged that the cluster arrangement would involve firing of all rockets simultaneously with gimbaling of four engines on "corners" of the cluster. If eight engines are used, it probably will involve fabrication of a stubby frame some 18 to 20 ft. in diameter and about 90′ in length around the four center rockets.

The remaining rockets would be attached to outer frame and would be jettisonable.

Navy to Spend $1.1 Billion For Missile Ships

Almost two-thirds of the Navy's $1.8 billion shipbuilding and conversion program released last week will go for missile ships including frigates, cruisers, destroyers and submarines.

Of the total estimated fiscal 1959 program, $1.1 billion will be spent on the missile ships. The only combatant ships in the program which will not employ missiles will be four attack submarines, utilizing the latest in torpedoes and other underwater weapons.

No individual cost figures are available, since the contracts will be let on a competitive basis. However, past cost figures and testimony before Congressional appropriations committees make possible close estimates.

The largest item in the program is for nine guided missile frigates which will employ the *Terrier*. At an average cost of $48.7 million each, the frigates will come to some $438.3 million. Two will be built at Naval Shipyards at Puget Sound and San Francisco, with the other seven going to qualified yards on a basis of competitive bidding.

Five guided missile destroyers are in the program at some $36 million each. They will be numbers DDG15 through DDG19, names to be assigned. These vessels will employ the forthcoming *Tartar*.

Three nuclear-powered guided missile submarines are in the program at an estimated cost of $56 million each. These subs carry the *Regulus* II. This includes two boats from the 1958 program, the SSGN 595, not yet definitely assigned, and the SSGN 596, plus one boat under the 1959 program—the SSGN 607.

• **Sub details**—In addition to the three Fleet Ballistic Missile submarines authorized under the fiscal 1958 program, two were assigned in July: the SSGN 601, which will be built at Newport News Shipbuilding and Drydock and the SSBN 602, which will be built at the Naval Shipyard, Portmouth. Each will cost an estimated $90 million.

Included in the overall figure are the conversions of the cruisers Columbus and Chicago to *Talos* ships. Conversions will cost an estimated $90 million each.

These contracts will be in addition to current construction as reported in m/r 14 July 1958, p. 11.

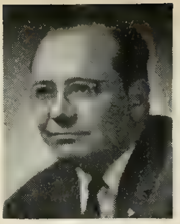
Vanguard Try Fails

The navy's latest attempt to launch its *Vanguard* Satellite—this time with an Army "weather eye" in its nose—failed Tuesday, after a countdown of more than six hours. Official reason for the failure was given as a malfunction, which triggered an automatic shutoff. Details of other *Vanguard* attempts and their results are printed on p. 22 of this issue.

Gen. T. D. White

Dr. Dryden

Gen. T. S. Power


Peter J. Schenk

Gen. Flickinger

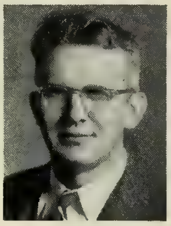
Alex Dreier

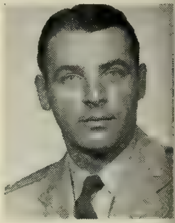
Gen. M. F. Cooper

Dr. G. P. Kuiper

Col. Pickering

Scott Crossfield


Dr. Turkevich


Capt. R. M. White

AFA Meet Stresses Space Age

List of speakers points up vastly increased interest in space problems as Air Force Association opens annual session and exhibit show at Dallas

by Peer Fossen

The Air Force Association's annual National Convention and Airpower Panorama will be held in Dallas, Texas, September 25 through 28. The convention, which will emphasize missiles and space age subjects, is the twelfth such meeting held by AFA since its formation in 1946. It is estimated that about 3,000 AFA members, Air Force personnel, industry leaders, government officials, and others interested in airpower will attend the meeting.

The highlight of the program is a Space symposium on September 26. Sponsored by AFA's Space Education Foundation, the symposium will be held under the theme "The Space Age in Perspective." The symposium's morning session features three speeches and a forum on the hypersonic X-15 research aircraft. After introductory remarks by AFA President Peter J. Schenk, Dr. John Turkevich, Professor of Chemistry, Princeton University, will speak on "The Challenge of Soviet Science." Following Dr. Turkevich, General Thomas S. Power, Commander, Strategic Air Command, will discuss "Strategic Aspects of Space Operations."

The X-15 Forum, panel under chairmanship of Brig. Gen. Marcus F. Cooper, Commander Air Force Flight Test Center, ARDC, Edwards AFB, will have the following members: Scott Crossfield, Test Pilot, North American Aviation; Captain Robert M. White, Test Pilot Air Force Flight Test Center, ARDC, Edwards AFB; and Walter Williams, Chief, High Speed Research Flight Station, NASA, Edwards AFB. The last item on the agenda for the morning session is a speech by Dr. Hugh L. Dryden, Deputy Administrator, NASA, in which he will outline NASA's role.

At the Space Age Luncheon that day, General Thomas D. White, Chief of Staff, USAF, will give a major speech.

The afternoon session of the Symposium will hear a speech by Dr. Gerard P. Kuiper, Director, Yerkes Observatory, University of Chicago, on the subject: "Exploration of the Moon."

• **Space Forum Planned**—Following immediately after Dr. Kuiper's speech there will be a Man in Space Forum under the chairmanship of Major Gen. Don Flickinger, Director of Life Sciences, ARDC, Andrews AFB. The four panel members will discuss topics of vital interest in the research being carried on to place man in space. Lt. Col. Rufus R. Hessberg, Chief, Aeromedical Field Laboratory, AFMDC, Holloman AFB, will discuss "Acceleration and Weightlessness in Space Flight." The problem of "Artificial Atmosphere in a Sealed Cabin" will be handled by Dr. Paul Webb, Chief, Environment Section, Aeromedical Laboratory, WADC, Wright-Patterson AFB, and Capt. Clyde H. Kratochvil, Chief, Dept. of Physiology, Bio-Physics, School of Aviation Medicine, Randolf AFB has as his topic "Medical Instrumentation in Space Flight." The last panel member, Col. John E. Pickering, Chief, Dept. of Radiobiology, School of Aviation Medicine, Randolf AFB will conclude the session with a speech on "The Significance of Cosmic Radiation to Manned Space Flight."

Alex Dreier, NBC commentator from Chicago, will function as moderator for the Space symposium. The Airpower Panorama will be held in the new Memorial Auditorium in downtown Dallas, where more than 100 displays from leading manufacturers will occupy 75,000 sq. ft. On opening day, the *Atlas* ICBM will be unveiled publicly in front of the Auditorium. This is the first public showing of the *Atlas*.

Participating in this event will be leaders from government, industry and defense, including Secretary of the Air Force, James H. Douglas, Generals Thomas D. White and Curtis E. Le May, respectively Chief and Vice Chief of the U.S. Air Force; other Air Force leaders, aircraft company presidents, congressmen, and Texas civic officials.

Space Scientists Use Sun For Moon Power Station

WASHINGTON, D.C.—Elements of an electric power station designed for use on the moon were demonstrated here last week by the Westinghouse Electric Corporation.

A working model of the moon power station was operated to show how the revolutionary generating unit would be powered by light from the sun. A modified vacuum tube, containing the same elements that would be used in a full scale station on the moon, absorbed a beam of light from a nearby sun lamp generating enough power to drive a small motor.

Guiding the space technology work within Westinghouse is the newly formed Astronautics Institute, headed by Dr. Peter Castruccio of the company's air-arm division in Baltimore.

Scientists at the applied research laboratory of the electronic tube division were responsible for the successful work in the theory, design and construction of the operating model of the moon station.

Dr. Castruccio, an authority in space guidance and communications problems, explained the construction and operation of the moon power station.

He pointed out that the sun, at zenith, pours upon the lunar surface something like 6,000 kw of power per acre, and that the proposed lunar power station would use this light or radiant energy to generate electrical power. The equivalent figure for the Earth varies with the atmosphere. On a clear day on a high mountain the sun would emit power on the order of 4,800 kw per acre.

• **Station components**—Basic components of the actual power station consist only of wire mesh and a chemically coated plastic. Giant sheets of a thin plastic material will be stretched and supported over several acres of the moon's surface. Coated on these sheets would be an extremely thin layer (about one micron thick) of a photosensitive material.

A thin wire mesh would then be placed parallel to, but slightly separated, from the plastic sheet and insulated from it. The photoelectric generator would then be ready to produce electric power.

As the sun's rays strike the plastic sheet, the coated surface would emit electrons. These electrons would strike the wire mesh, generating a voltage. Upon closing the circuit between the wire grid and the coated surface through a suitable load, current would flow.

This type of electric power plant is the lightest known to man. The total weight of required material would amount to about three pounds per kilowatt.

"In practice," said Dr. Castruccio, "since the voltage generated by each cell is only a few volts, several cells need to be connected in series. This can be done quite easily by separating the sheets into several sections by insulating strips, and connecting the sections in series. Doing this, practically any voltage, including 110 volts dc, can be obtained."

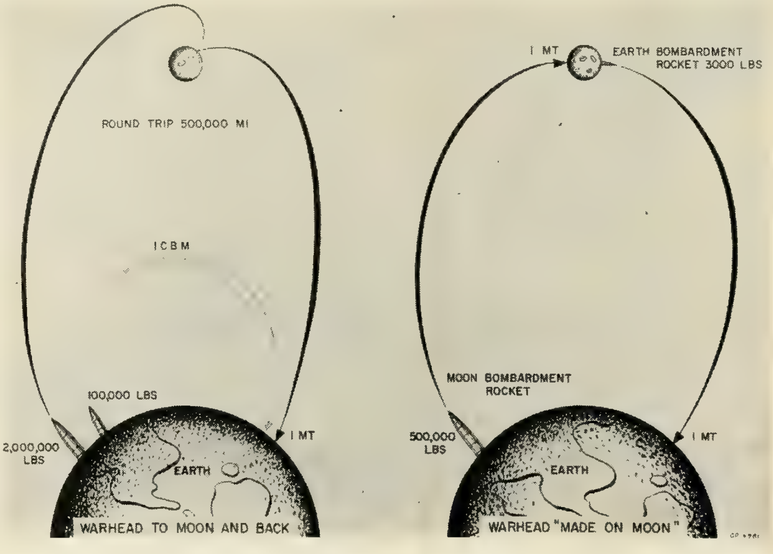
• **Advantages**—One of the chief advantages of this device is its exceedingly long life. Even relatively large meteorites impinging upon it would destroy only a portion of the photoconverting surface without disabling the generator.

There would be a small reduction in power output directly proportional to the area destroyed. To prevent meteorites from accidentally severing the power cables, these would be flat rather than cylindrical. A meteorite would merely punch a hole in the flat conductor without severing it.

As to solar conversion efficiencies, Dr. Castruccio pointed out that insight gained into the photoelectric phenomenon now shows promise of generators having up to 25% efficiency.

Once the power station is constructed, it would operate for 14 days at a time, since there are 14 days of sunshine followed by 14 nights at any one spot. Westinghouse scientists envision construction and interconnection of a number of these power stations all around the surface of the moon. With this type of lunar electrical network, continuous power would be assured to any point on the moon.

Dr. Castruccio said some of the



STRATEGIC ADVANTAGES of a self-supporting lunar base, according to Westinghouse's Dr. Peter Castruccio, include these: to bombard the Earth with a one-megaton nuclear warhead, from the Moon, would require a take-off weight of about 3,000 lbs.; the same warhead launched from Earth to bomb the Moon would require a take-off weight of the order of 500,000 lbs. A military base on the Moon is thus in the enviable position of a fortress located on a high mountain, which can easily rain projectiles into the valley, but which is almost invulnerable to a valley-bound adversary.

It would, however, not be practical to construct a base on the Moon with the intent of supplying it entirely from Earth. A nuclear warhead lifted from Earth, landing on the Moon, stored there and subsequently relaunched towards Earth would require—with advanced propellants—an initial take-off weight of the order of two million pounds. By contrast, an ICBM to accomplish essentially the same purpose requires a take-off weight of only 100,000 pounds. A similar balance applies to using the Moon as an interplanetary stopping point, since the characteristic velocity of an interplanetary mission is increased in this case by more than twice the lunar escape velocity.

. . . sun for moon

materials needed to construct the lunar power station may be found on the moon itself, though no way is presently available for on-the-moon conversion of such raw materials into usable products. He added, however, that Westinghouse is investigating ways of determining the presence and properties of the moon's materials through the use of unmanned lunar probes or satellites.

At the recent WESCON show, the Laboratories Div. of Hoffman Electronics Corp. disclosed the feasibility of solar energy converters capable of delivering up to 2,000 watts as power supply stations and satellites.

Hoffman has two proposed configurations, based on utilizing silicon solar cells, for such a converter. One is a balloon, which would inflate after the vehicle reaches outer space. The other involves a planar arrangement which could be unfolded from the launching vehicle after it is placed in orbit.

Point Arguello Range Contruction Pushed

Navy bureaus and offices in southern California received orders from the Secretary of the Navy last week to push construction of the new Pacific Missile Range, at Point Arguello, Calif.

The orders read that "establishment, operation and support" must be assigned high priority.

Two contracts for work on the new facility were let recently: Alco Construction Co. of Beverly Hills was awarded the construction of a range operations building, transmitter and receiver; Alpan Construction Co. of Long Beach received a contract for construction of an administration facility.

Plan Separate Company for Space Tech Labs

In order to allow the parent company to compete for production contracts for Air Force missiles, Ramo-Wooldridge Corp. will establish its Space Technology Laboratories as a separate division, it was disclosed last week.

The disclosure came in a proxy statement, issued by Thompson Products Inc., as a preliminary to a special stockholders' meeting called for Sept. 30 at Cleveland to approve the proposed merger of Thompson and Ramo-Wooldridge.

Reason for the separation of STL from its parent company lies in government rulings that because of the nature of the work of the laboratory division (as technical director for the Air Force intercontinental and intermediate-range dridge itself may not compete for proballistic missile program), Ramo-Woolduction contracts on the Atlas, Titan and Thor missiles.

Ramo-Wooldridge would retain ownership of all the stock of the new company formed out of STL—this ownership to pass to the new Thompson-Ramo Wooldridge if the stockholders approve the merger.

The STL division has accounted for 60% of the aggregate consolidated net sales of Ramo-Wooldridge since 1954, the proxy statement said.

Satellite Data Published By Science Academy

The sixth in a series of IGY satellite reports has been published by the IGY World Data Center A, National Academy of Sciences. The publication, entitled "Reports and Analyses of Satellite Observations," contains Moonwatch catalogues of May through June, 1958.

Also included in the paper are preliminary data on the mass-area ratios of satellites 1958 Beta 1 (carrier rocket) and 1958 Beta 2 (satellite proper of *Vanguard* I), the descent of 1957 Beta 1 (*Sputnik* II) and positions of Satellite 1957 Beta 1 during the first 100 revolutions.

Material in the booklet consists of special reports 15 and 16 of the Smithsonian Astrophysical Observatory and excerpts from special report 14.

First *Atlas* Crews Start Training Program

Student missilemen who will operate the first operational *Atlas* ICBM Squadron entered their first day of training at Vandenberg Air Force Base, Calif., last week.

The initial class of ICBM training students at the base will last for 22 weeks. The members of the 576th Strategic Missile Squadron, assigned to the base, will receive instructions in the guidance and computer system and will become a part of the *Atlas* guidance team.

Classroom instructions for the first group of men are provided by contractors from General Electric and Burroughs Corporation under the supervision of the 394th Missile Training Squadron, commanded by Cononel A. W. Stephens.

Last month the first class in Thor (IRBM) integrated weapons systems training started with 57 students. IRBM training is conducted by the 392nd Missile Training Squadron, commanded by Col. Robert W. Christy.

Naval Powder Factory Becomes Propellant Unit

The Navy has announced that the name of its Indian Head, Md., powder factory has been changed to the U.S. Naval Propellant Plant. Rear Admiral Paul D. Stroop, Chief of the Bureau of Ordnance, explained that the new name more accurately reflects the modern tasks being performed there.

The plant's present functions are primarily in manufacture of large propellant grains used in such missiles as *Terrier, Talos, Sidewinder, Weapon Able, Mighty Mouse* and other rocket motors. It is also engaged in research and development work in connection with missile programs.

The Indian Head facility has recently received an authorized personnel increase of over 100 people, about 25 of whom will be in the process engineering phase.

Douglas Team Enters *Minuteman* Competition

Douglas Aircraft, Hughes Aircraft, and Food Machinery and Chemical Corp. have teamed up to enter the *Minuteman* ICBM competition. The solid propellant missile is an Air Force project expected to produce an "instant and massive retaliation" capability for this country to replace both *Atlas* and *Titan*.

Douglas will be manager of the team, with Hughes responsible for electronics and FMC for ground handling equipment. A "*Minuteman* Assembly and Test Policy Board," headed by Donald W. Douglas Jr., has been established to provide major policy direction.

This board will meet at least twice a month to review the program, and also has as members A. E. Raymond, v. p.—Engineering at Douglas; L. A. Hyland, v. p.—General Manager at Hughes; J. M. Hait, Executive v. p., Director of Engineering for FMC; E. P. Wheaton, Douglas Director of Missiles and Space Systems Engineering, and Kenneth B. Bingham, General Manager of Douglas Aircraft's new *Minuteman* Division.

NATO Experts Here To Discuss Missiles

A group of some 40 NATO military and technical experts have started a three-week series of talks in the U.S. in connection with development of coordinated missile production within the NATO countries. The missile experts represent West Germany, Great Britain, France, Italy and the Netherlands.

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Another typical example of how
Bridgeport Aluminum Cold Forgings
improve product performance and saleability

This general purpose "WIG-O-FLEX" flexible coupling, manufactured by E. B. Wiggins Oil Tool Co., Inc., Los Angeles, is widely used in the aircraft industry for fuel lines, as well as air, oil and occasionally hydraulics. It operates over an ambient temperature range of −65°F to +450°F, usually within a 125 psi maximum operating pressure.

Formerly a permanent mold casting of 356 T-6 aluminum alloy, an alert engineering department saw product improvement possibilities by cold forging without increasing cost.

Hollow, closed-end blanks are now cold forged from 2014 T-6 aluminum alloy. Parts are subsequently finished using high-production "chuckers." The final advantages resulting from cold forging are as follows:

STRENGTH—Approximately 3 times greater than before.

WEIGHT REDUCTION—⅓ less weight than former coupling. Increased material strength permits thinner walls. Wall thickness now limited only by mechanical problems of turning and knurling.

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IMPROVED APPEARANCE—Bright finish, uniform knurling and color anodizing has vastly improved eye appeal.

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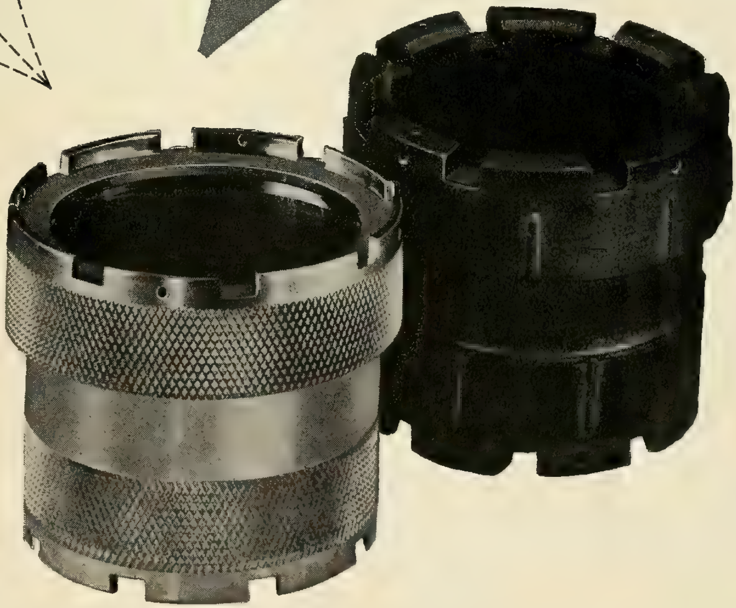

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Third Inflatable Satellite Hits 160,000—Fails

WALLOPS ISLAND, VA.—National Advisory Committee for Aeronautics has released further details on its inflatable aluminum-foil type satellite program, following the third flight test at the Pilotless Aircraft Research Station here.

The test—second for the 12-foot diameter sphere which will be scheduled in the Explorer program—failed to inflate. Tracking radars lost the rocket after it had travelled about 160,000 feet. It was not equipped with telemetering instrumentation, and NACA was unable to determine if the sphere had been ejected.

The 12-foot sphere also was flight-tested April 25 and inflated at an altitude of 50 miles. It was tracked visually for some 300,000 yards. A 30-inch sphere, slated as a sub-satellite for the *Vanguard* program, was fired May 21.

Technicians had hoped that the last attempt would allow them to determine atmospheric density at an altitude of 80 miles. The 40-pound research model was four feet long and 7.5 inches in diameter. The sphere weighed nine pounds.

• **How it's done**—The model, in addition to the folded sphere, included a timing mechanism, a 1500 psi air bottle and bellows to eject and inflate the sphere and a simple explosive mechanism to separate the model from the rocket motor. A solid-fuel first stage *Nike* rocket motor and a solid-fuel second-stage *Cajun* rocket, were used as boosters. Launching weight of the 26-foot rocket was 1350 pounds.

The rocket was fired about 30 minutes after sunset at an elevation angle of 80 degrees. First stage burned for about three seconds and the model coasted for about 20 seconds to an altitude of 40,000 feet. The second stage clearly fired for three seconds. The burned out second stage remained attached to the payload, as planned, and the combination coasted upward leaving the Earth's shadow and entering into sunlight.

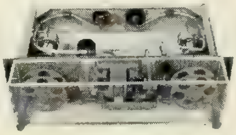
If the sphere had been ejected, it would have been as visible as a Zero magnitude star about 150 seconds from launch, and would have remained in view for about four minutes.

NACA personnel pointed out that expansion plans for Wallops Island include the capability to launch satellites under 100 pounds in weight. Visiting newsmen were given details of a multi-million dollar expansion program for the facility as reported in m/r (Sept. 1, p. 13).

Wallops Island, according to AC now devotes 90% of its effort to flight research in the hypersonic range.

AF Moves Bomarc Testing From Canaveral

• **Cape Canaveral**—The transfer of AF *Bomarc* intercept missile testing facilities from Cape Canaveral to the Air Proving Ground Center missile site on Santa Rosa Island, near Fort Walton, Fla., is underway and scheduled for completion late next year.



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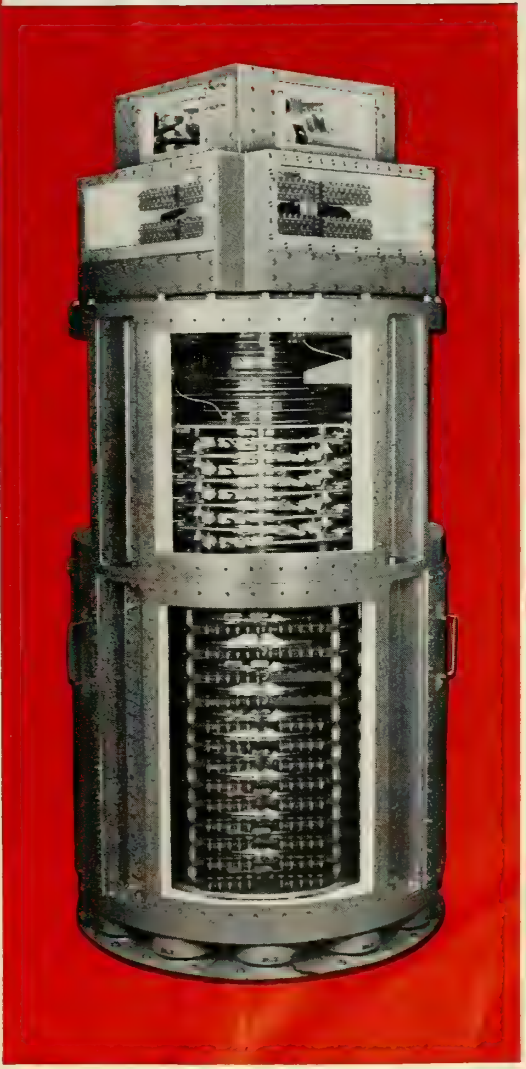

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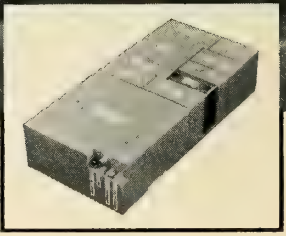

NAVTAC: "Pipeline" to a happy landing

The uniqueness of the new NAVTAC en route navigation and instrument landing system by Stromberg-Carlson is in its *combination* of functional modules.

The NAVTAC equipment is an assembly designed to provide high-performance aircraft with the TACAN navigational aid, plus marker beacon receiver, glide slope and runway localizer for instrument landing situations.

The entire system is packaged in a compact unit only 5" high, 10½" wide, 22" deep, and weighing only 47.5 lbs. Individual modules can be separated up to distances of several feet without any adverse effect on performance.

The equipment is designed to meet the rigorous environment of the high-performance aircraft of today and tomorrow. Its operating ambient temperature range is −60 to +125 degrees C. at altitudes up to 70,000 feet. Widespread use of semiconductors in the ILS receivers and TACAN circuitry means high reliability, small size and low power consumption.

Included in the design is the capability of performing complete preflight confidence tests with the use of a small auxiliary test set.

Complete technical details on the NAVTAC system are available on request.

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Wide Industrial Base Supports *Atlas* Program

The size of the industrial pyramid supplying the missile prime contractor was dramatically illustrated in a report released by Convair Astronautics Division of General Dynamics Corporation.

A total of 1,209 companies were listed as primary suppliers who contributed directly to the *Atlas* ICBM. Covering 32 states, these firms provided raw materials, parts, equipment or special services for the Air Force missile during 1957.

The report, first of its kind ever made public, excluded equipment furnished by the government and indirect suppliers of the Convair-built missile which is programed to go into the Air Force inventory as the Western World's first truly intercontinental missile.

"If an overall total could be compiled," Convair Vice President J. R. Dempsey said, "we would expect it to show that more than 5,000 firms are participating in development of the *Atlas* weapon system as primary or secondary suppliers."

Approximately $90 million was paid out to companies in 344 cities and towns. Eighty-six percent of the *Atlas* suppliers were small business firms (less than 500 employees) and they received 65% of the 1957 disbursements.

Over half of the primary suppliers—661—are in California. Other states which led the Convair list included: New York: 124; New Jersey: 74; Massachusetts: 57; Illinois: 57; Pennsylvania: 48; Connecticut: 44; Ohio: 40; Indiana: 16; Michigan: 15; Missouri: 10.

Systems Concept Boosted by Navy Evaluations Head

Dallas—The "weapon system" concept got a boost when Vice Admiral John H. Sides told the 60th annual convention of the National Association of Life Underwriters that "the best guided missile in the world would be useless unless every part of the system is in place and functioning."

As director of the Weapon System Evaluation Group, Department of Defense, Admiral Sides is concerned with weapon systems of all U.S. Military Services.

"In this day of high speeds, short times and long distances, we are forced more than ever to recognize the absolute necessity for putting all the pieces together into a well-knit organization which can insure that we achieve the full potentialities of our weapons system," Sides said.

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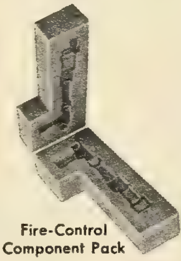
Fire-Control Component Pack

A Paratex pack is the only cushioning for delicate instruments of any shape, size or weight that permits a completely *Static Shape* and *Fully Neutralized* weight.

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Circle No. 29 on Subscriber Service Card.

Here is the *Vanguard* Record

Satellite Record Isn't Good, But Program Has Produced Much Useful Information

by **Norman L. Baker**
and
Donald E. Perry

WASHINGTON—The current rumblings regarding the uncertain future of the Navy's *Vanguard* program is apparently not denting the optimism of Dr. Hagen's team in the continuance of their planned objectives.

Certainly many of the NRL people are deeply concerned—knowing that a poorly informed public could seriously endanger any future plans for the future use of the team.

Many top officials predict that ARPA will cancel any further launching attempts if the September 16th shot is a failure, and the Hagen team would be overlooked for future space programs. What would happen to the remaining hardware if this decision is made has not been determined.

While *Vanguard* (at press time) has failed to place into an orbit a full-size satellite, it has piled up an impressive array of technological accomplishments—accomplishments that are being utilized in present and future military weapons and space vehicles.

The Air Force's *Thor-Able* lunar rocket depends heavily on rocket engine and guidance technology gained in the development of the *Vanguard* rocket. There are also unconfirmed reports that the Army may use some *Vanguard* components in their lunar shots.

The 200 people comprising the *Vanguard* team have a tough schedule ahead if they are to complete the series of launchings planned before the end of the year. Yet, they are confident the schedule will be met and at least one full-size satellite will be put into orbit.

Five shots (including SLV-3) remain to be launched in the current program. SLV-3 carrying instrumentation for studying the earth's albedo is an experiment of the Army Signal Corps. With a rotation of one revolution per second, the instruments will measure variations in light intensity reflected from the earth.

A photosensitive cell would trigger the instruments into operation when the satellite is over the light side of the earth and shut them down when in the shadow. Play-back in one minute-bursts from a storage tape will take place during the time it is on the dark side of the earth. In addition to the albedo instruments there will be micrometeorite impact detectors and temperature gauges.

Experiments in the later satellites, continuing through SLV-7, will follow the NAS-16Y policy of giving each experiment a maximum of two chances. After first success the next experiment is flown.

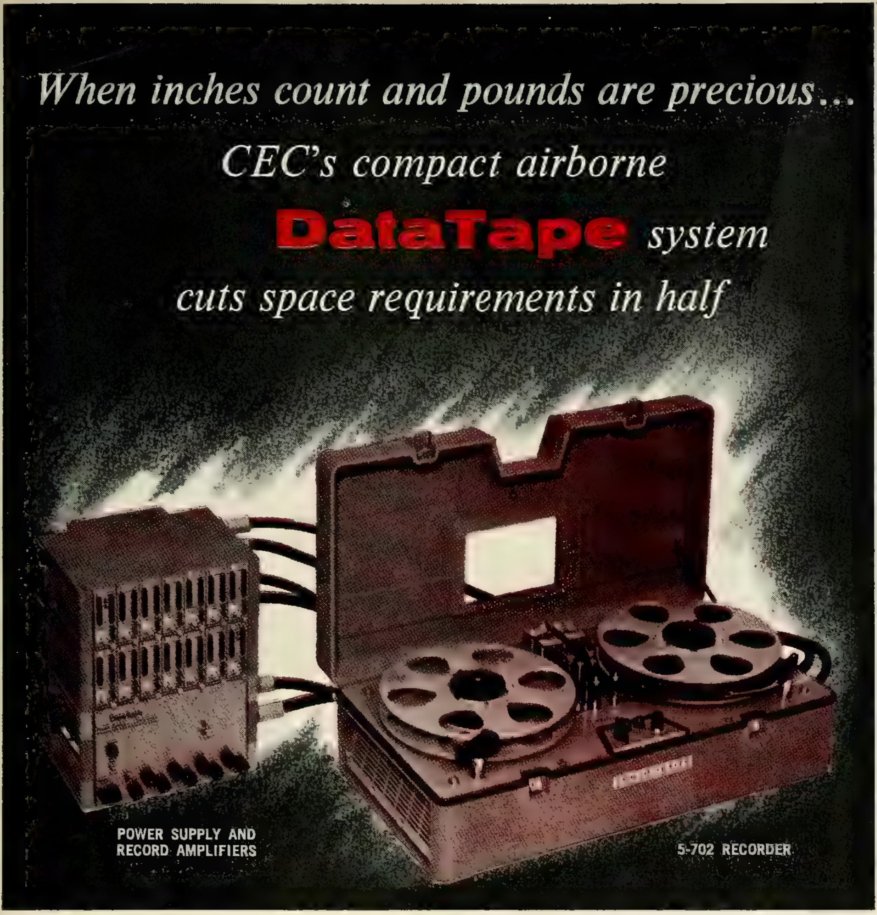
SLV-4 will attempt to place a 13-inch magnetometer satellite and a

(*continued on page* 25 *and* 26)

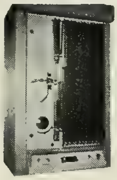
Vehicle Development Test

Test Vehicle Number and Date of Test	Purpose of Test	Composition of Test Vehicles and Flight Performance				Results of Test
		First Stage	Second Stage	Third Stage	Test Satellite	
1. **TV No. 0** **8 Dec 56**	Set up the Vanguard launch facility and to test out the facility itself before field tets of the **Vanguard** vehicle components. To be tested out and made workable before the vehicle test program could proceed.	**Viking No. 13**—fitted with **Vanguard** telemetering and instrumentation. **Launched & flown successfully.** Reached an altitude of 126 miles and range (distance from launch site) of about 183 miles.	None.	None.	None.	**Completely Successful.** Instruments in vehicle transmitted all desired flight information to the stations on the ground at Cape and down range. Vanguard tracking radars ground stations and data reduction facilities and methods proved out.
2. **TV No. 1** **1 May 57**	Flight test the newly developed Vanguard third stage (solid propellant rocket by Grand Central Rocket Co.) This was a test of spin up, ignition of third stage at altitude, separation of the two stages, guidance of the whole vehicle and third stage propulsion.	**Viking No. 14**—**Launched and flown successfully.** Vanguard control systems worked well. Nose cone contained instrumentation in addition to the third stage.	None.	**Vanguard. Spin up, separation and propulsion completely successful.** Reached an altitude of 120 miles and range of 450 miles after successfully separating in flight from the first stage.	None.	**Completely successful.** All test objectives were met.
3. **TV No. 2** **23 Oct 57**	**First flight test of the Vanguard first stage** and of the three-stage rocket configuration. Major objectives were to: test the newly developed (General Electric) first stage engine and propulsion system; vehicle structure and, guidance and control under powered flight.	**Vanguard.** Launched and flown successfully. Guidance and control worked well. The entire vehicle reached an altitude of 109 miles and a range of 330 miles.	**Dummy Vanguard.** Was built to look like the real Vanguard to test the vehicle structure, the second and third stages were not loaded with live propellants.	**Dummy Vanguard.** Same as second stage.	None.	**Completely successful.** First stage propulsion performed above minimal specifications. The overall vehicle structure proved sound and capable. Guidance and control worked well.

When inches count and pounds are precious... CEC's compact airborne DataTape *system cuts space requirements in half*



ADJUSTABLE TAPE LOOP ATTACHMENT FOR 5-752 RECORDER/REPRODUCER



5-781 MAGNETIC-TAPE RECORDER/REPRODUCER (CONTINUOUS LOOP)

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The highly flexible 5-702 provides 7- or 14-track operation with *exclusive front-panel switch selection of all six tape speeds* from 1⅞ to 60 ips, using 10½″ standard NARTB reels or special CEC high-performance reels of ½″ or 1″ tape.

A single cast aluminum alloy case houses seven miniaturized record amplifiers. The system converts readily to 14-track operation by simply adding a second 7-amplifier case and changing tape width.

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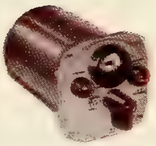
Use of all-metal-surface playback heads permits simultaneous downstream monitoring of all tape tracks—continuously and virtually coincident with the recording of test data. These reproduce headstacks also allow the 5-702 to be used as a laboratory playback machine.

The new airborne system provides FM, PDM or Analog recording through its interchangeable plug-in amplifiers, and is completely compatible with CEC's 5-752 Recorder/Reproducer.

For complete details, contact your nearest CEC sales and service office or write for Bulletin CEC 1607-X5.



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NEWS FROM FLEXONICS

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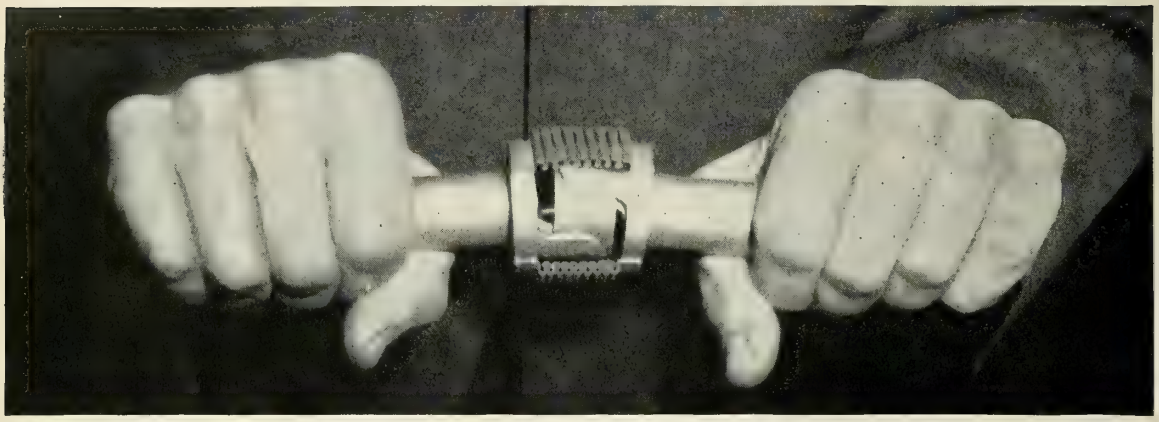
One of a series of reports to help you make more effective use of Flexon products.

THE FLEXON GIMBAL JOINT

A new approach to absorption of ducting motion in any plane



Flexon Gimbal Joint cutaway to show how it permits motion in any plane yet is self restrained.

To answer a critical motion absorption problem in the most advanced jet aircraft and missiles, Flexonics engineers reached back over 500 years. They took the gimbal principle—the same one used in the compasses of Columbus, Magellan, da Gama, et al—and applied it to a flexible connector. The result is the Flexon Gimbal Joint.

Here is a joint designed especially for the supersonic space age. Its design recognizes the problems of thermal expansion, installation misalignment, air frame deflection and high end loads which are so critical in modern jet aircraft and in missiles and rockets.

The simple, efficient design provides a combination of advantages available in no other type of flexible connector:

1. Completely self-restrained.
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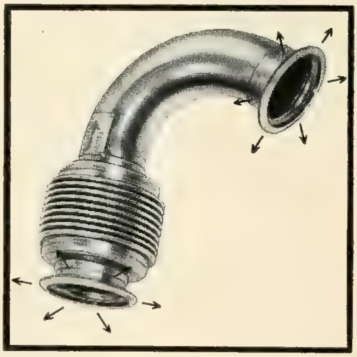
3. Reduced pressure drop (liners incorporated).
4. Reduced system weight—heavy anchors are eliminated—simple line supports are the only requirement.
5. Minimum envelope.
6. Maximum fatigue life verified by comprehensive laboratory tests.

Significant, too, is the fact that the Flexon Gimbal Joint will take motion in any plane. Joints taking motion up to 7° have been manufactured and are in service. The units are made in high strength corrosion resistant alloys to meet specific requirements. Sizes range from 1″ through 4″.



The Flexon Gimbal Joint can be used to join a variety of tubing shapes to make a wide range of connector types.

Engineering Assistance on Ducting Problems

The Flexon Gimbal Joint is only one of many Flexonics developments for the advancement of the science of aircraft and missile plumbing. Other products include metal, synthetic and plastic hose, flexible ducts, liquid oxygen lines, pinned elbows, high pressure ducting and thin wall tubing.

Out of this background has come unmatched experience proved in many of the nation's most advanced aircraft, rocket and missile programs. This experience is available to help you in the solution of your most advanced design problems. Put it to work!

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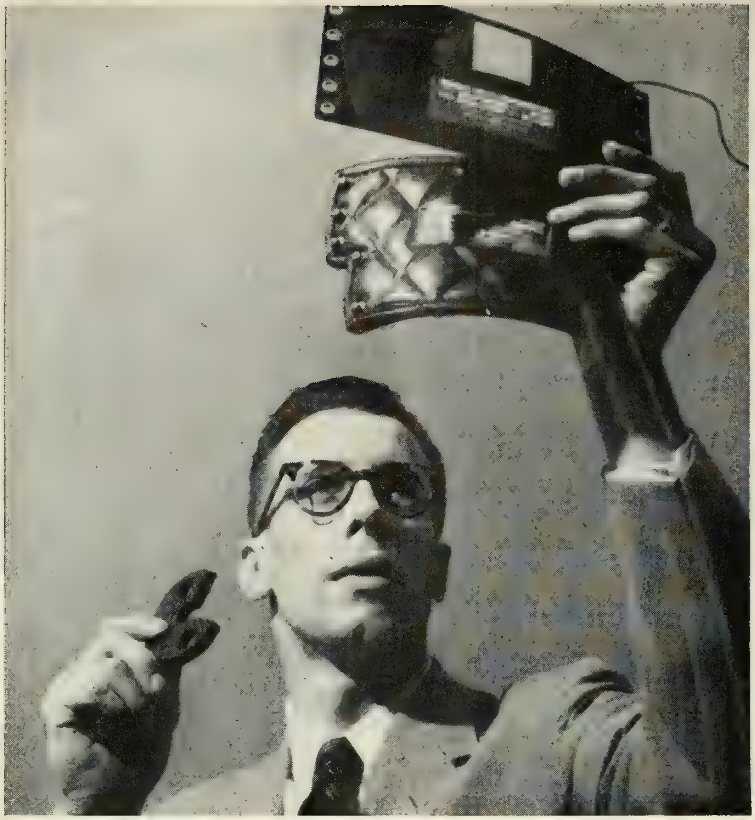
. . . here is the Vanguard record

Test Vehicle Number and Date of Test	Purpose of Test	Composition of Test Vehicles and Flight Performance				Results of Test
		First Stage	Second Stage	Third Stage	Test Satellite	
Test Vehicle No. 2 Back-up Not Flown	Since the test of TV-2 was so successful there was no need for the contingent repeat test for which this was available.					
4. TV No. 3 6 Dec 57	First flight test of the complete, three-stage launching vehicle rocket system. **Prime objective was to test the new second stage which had never before been flown.**	A malfunction occurred and fire broke out in the first stage which quickly consumed the vehicle on the launch stand.	Due to mishap in first stage, second and third stages had no chance to perform.	Same as second stage.	**6" test sphere.** A small test satellite was placed in the nose cone so that if the over-all test vehicles performed beyond expectation during the test program the test sphere might go into orbit.	**Not successful.** Test objectives were not met. Launch stand was damaged. Since the project had been authorized only one launch stand at Canaveral, all testing using the stand was delayed.
5 TV No. 3 Back-up 5 Feb 58	Test Vehicle No. 3 Back-up was constructed for the purpose of repeating the tests scheduled for TV-3 in case all test objectives were not met with TV-3. Prime objectives: to flight test the second stage and the over-all guidance and control system.	In flight for 60 seconds. At that time, a component malfunction in the controls system resulted in a "hard over" engine which broke the vehicle in two and terminated the flight.	No chance to perform because of control component malfunction.	Same as second stage.	**6" test sphere.** Instrumentation consisted of two temperature sensitive Minitrack oscillators—one of which operated on solar power.	**Partially successful.** First flight of the full Vanguard guidance and control system. Operated well during powered flight. Second stage was not ignited.
6. TV No. 4 17 Mar 58	Further flight test of complete Vanguard three stage vehicle system. All modifications dictated by results of previous test.	**Launched and flown very successfully.** All components worked well. The first stage propelled the vehicle higher and further than the minimum required.	Lifted to an orbital altitude of 400 + miles, spun up the third stage at the proper time then fell back to earth as planned about 1500 miles from launch site.	Propelled test satellite into orbit 2,466 miles from the earth's surface at apogee and 400 miles at perigee. Calculated to stay in orbit for 200 years.	**6" test satellite.** Separated from the third stage after burnout as planned. Solar cells are still working and will continue to transmit signals for an indefinite period.	**Completely successful.** All components, propulsion, guidance and control, ground stations, telemetering, Minitrack network, tracking radars, etc., performed assigned missions in a satisfactory manner.
TV No. 4 Back-up	This vehicle was available in case test objectives of the TV-4 flight were not completely met. Converted to a true satellite launcher.					
7. TV No. 5 28 Apr 58	Last test of all components prior to start of IGY Satellite Launching Program.	**Launched and flown successfully.** Burning time, velocity, cut-off separation, guidance and control all excellent.	Ignition and separation from first stage good. Propelled vehicle up to an orbital altitude of 340 miles (specs call for 300 miles). However, two minor components (electrical relays) malfunctioned and failed to signal the third stage to fire.	Did not receive signal from second stage "brain." Therefore, did not fire and it, along with the second stage impacted at a point 1500 miles from the launch site.	**20" test satellite.** This was the first flight of a fully instrumented IGY type satellite.	**Successful.** The design of the 20" fully instrumented satellite proved out under flight conditions. Propulsion of the first stage was excellent for the fourth time in five tries. Second stage propulsion was above par.

All Subsequent Vehicles Are True IGY Satellite Launching Attempts

Satellite Launching (SLV) Vehicle number & Status	Flight Objective	Flight Performance of Vehicle Components				Results of Flight
		First Stage	Second Stage	Third Stage	Scientific Satellite	
1 SLV No. 1 Launched 27 May 58	To place in orbit around the earth a Vanguard-IGY 20" diameter, 21½ lb, spherical satellite plus the 50 lb third stage rocket casing. Solar Lyman-Alpha Radiation and Space Environmental measurements.	Launched and flown very successfully. Lifted vehicle to required altitude, obtained the right velocity and separated successfully from the second stage.	Lifted vehicle to an altitude of 368 miles. Engine did not cut off properly at the end of its powered flight causing the vehicle to fly with its nose at an upward angle instead of parallel to the earth.	Satellite reached a peak altitude of 2200 miles and traveled some 7500 miles from the launch site and landed near the East Coast of South Africa.	All instrumentation worked perfectly and scientific data was obtained.	**Partially successful.** Over-all, the satellite flew for 20 minutes.
2. SLV No. 2 Launched 26 June 58	To place 20" satellite in orbit. Instrumentation was to measure X-radition in space emanating from the sun.	Launched and flown very successfully for the sixth time in seven tries (including test flights).	The motor cut off prematurely due to low chamber pressure and terminated the flight.	Second stage malfunction prevented firing of third stage.	All instrumentation was working perfectly when the flight terminated.	**Not successful.** The very limited number of vehicles in the over-all program makes evaluation of flight results and testing before each flight of extreme importance.



THOMPSON PRODUCTS NEEDED A HEATER FAST . . .

Here's how General Electric solved customer's heating problem—in 3½ days!

Recently, Thompson Products, Inc., ran into a problem: components were not available which would function at the extremely low temperature ambients required for a control being manufactured for a new USAF fighter. A holdup here could halt the entire aircraft program.

A General Electric sales engineer was called in. To General Electric's Specialty Heating Products plant at Coxsackie, N. Y. went a call. Asked the customer: "How soon can you design, develop and deliver a prototype heater for our airborne system component?" The General Electric answer "78 hours — 3½ working days—after we receive your specs."

Project preparations started immediately. When the rough equipment sketches arrived, the team went into action. At 11:00 A.M. Thursday — 3½ days later — the heating unit passed final inspection; was on its way. Final result: the aircraft program never slowed down.

THIS IS ONE EXAMPLE of how quickly General Electric can solve straight forward thermal conditioning problems. When you have a heating problem, call in your nearest General Electric sales engineer.

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30-inch expandable ball on satellite in orbit.

SLV-5 will be a 20-inch satellite loaded with radiation balance equipment. This experiment would supplement the current *Explorer* experiments. Instrumentation will be by the University of Wisconsin. SLV-5 will be a repeat of SLV-4 if first magnetometer try is unsuccessful. SLV-6 will carry the remaining 16Y experiment depending on the successes or failures of the earlier flights.

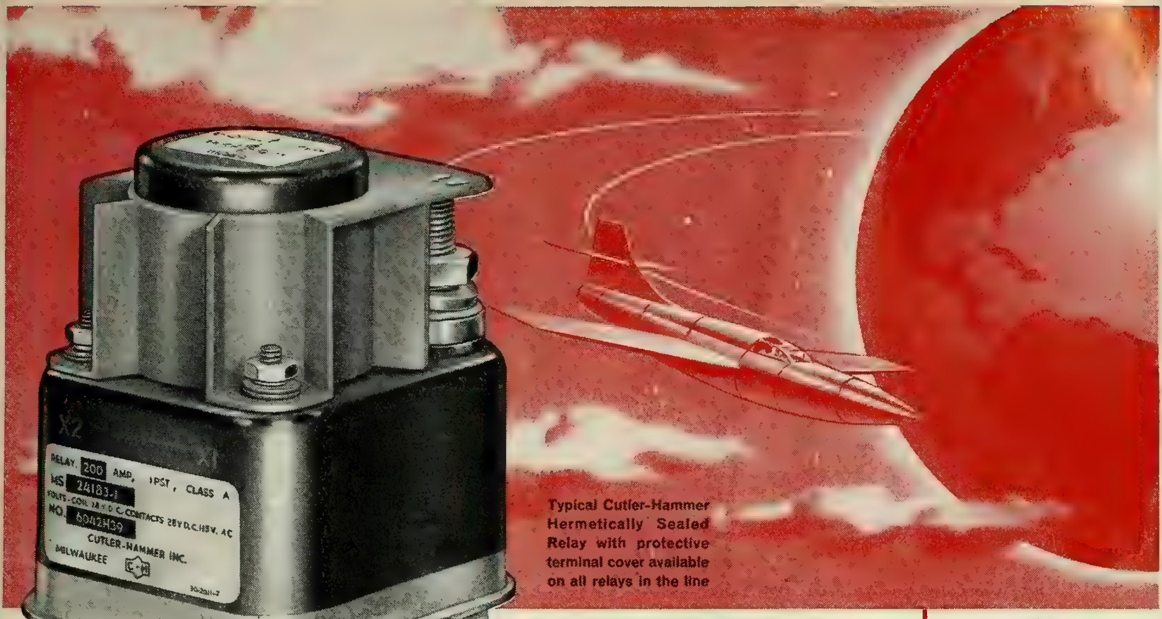
SLV-7, the TV-4 back up vehicle, will use the Allegany Ballistics third stage rocket now in use on the *Thor-Able* lunar probe. The satellite will contain 50 pounds of instruments with a total weight in orbit of 100 pounds. Instrumentation for this one is yet to be determined.

An alternate third stage of even higher performance than the current Allegany Rocket may be available in time for this flight. Development on the rocket has been underway since the beginning of the program and has now reached the testing stage. Allegany has been with the *Vanguard* program as a back-up. Seven of the engines have now been shifted to the lunar program.

After the satellite launchings have been completed, the NRL team will, if NASA or ARPA gives the go-ahead, initiate a lunar research vehicle program. Again, components of the *Vanguard* rocket would be utillized. It has been reported that the *Vanguard* lunar project would develop satellite systems with payload up to 50 pounds.

Plans reportedly called for deliveries of first launching rockets within four months after the official go-ahead. The Allegany Ballistic third stage and a more powerful first stage would be used for these shots. It is not known whether the first stage would be an entirely new system or would use exciting hardware, although the description tallies closely with Air Force *Thor-Able* lunar vehicle.

The original *Vanguard* program will be completed during the current fiscal year. The total budget estimate for the project to finance all costs from start to finish is $111 million. Of this, $97 million is allocated to the Naval Research Laboratory. The remaining $14 million goes to other departments as follows: National Science Foundation, $5 million; Air Force, $8 million, and Army, $1 million. Vehicle development, testing, production, launching and flight operations and support, vehicle telemetering, assistance to Army and Air Force projects which use *Vanguard* vehicles have cost $73-million.



Typical Cutler-Hammer Hermetically Sealed Relay with protective terminal cover available on all relays in the line

Cutler-Hammer Hermetically Sealed Relays Proved by Years of Service

The broad line of Cutler-Hammer Hermetically Sealed Power Relays is the only family of such advanced aircraft relays to be proved by years of actual service. This line has been in mass production for more than three years. Thousands have been shipped and installed . . . and their performance has been outstanding.

Cutler-Hammer Hermetically Sealed Power Relays were designed to meet the MS drawings and Mil-R-6106. Testing done beyond the requirements of Mil-R-6106 for a number of air frame builders has resulted in the selection of these relays for many "special use" applications. The auxiliary contact arrangements possible with these relays often permit the elimination of another relay in circuit planning.

Whether you are building air frames, missiles, tanks or space ships, you will find the best relay for your purpose in the large family of Cutler-Hammer Hermetically Sealed Relays. Be sure you have the latest data on this constantly growing line. Write *now* on your company letterhead for Pub. EE 140-T-224.
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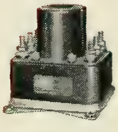
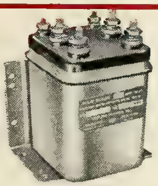
50 amp. single pole, single throw Class A power relay.

200 amp. single pole, single throw Class B power relay with N.O. and N.C. auxiliary contacts.

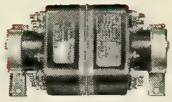
25 amp. three pole, single throw Class B power relay with N.O. and N.C. auxiliary contacts.



100 amp. three pole, single throw Class B power relay.



50/25 amp. single pole, double throw Class B power relay.



25 amp. three pole, double throw reversing duty Class B power relay.

Cutler-Hammer Power Relays—Finest in Flight

Cutler-Hammer Hermetically Sealed Relays are designed to meet Spec. Mil-R-6106B. Operate at 80,000 feet. Class A can operate in ambient temperatures to 71°C; Class B in ambient temperatures to 120°. Class B are available with or without auxiliary contacts.

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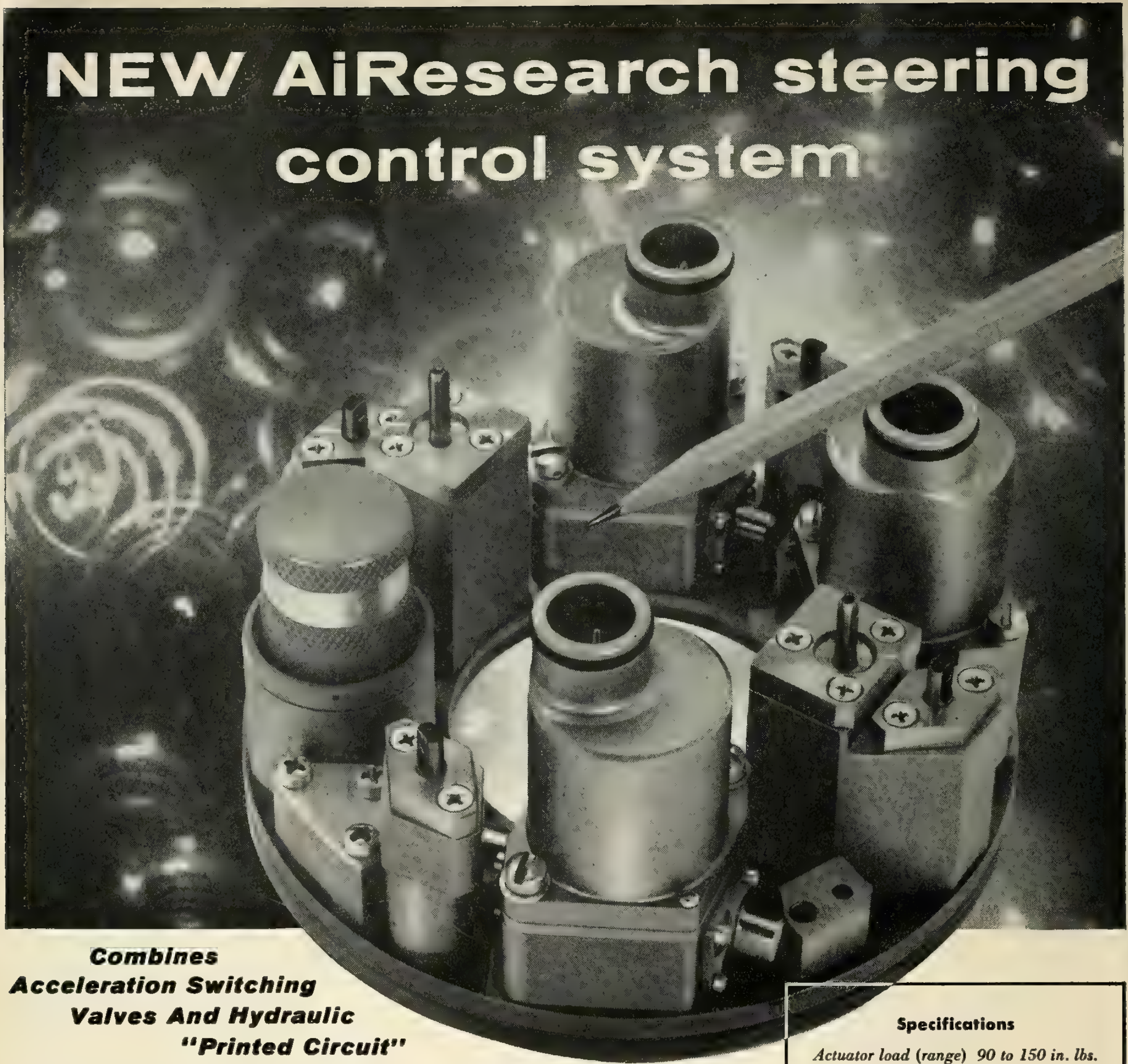
Circle No. 14 on Subscriber Service Card.

NEW AiResearch steering control system



Combines Acceleration Switching Valves And Hydraulic "Printed Circuit"

More reliable and responsive... this lightweight electro-hydraulic steering control system converts low-level electronic signals from the main guidance system into hydraulic energy which actuates the mechanisms steering the missile.

Packaged as an integrated unit, the three servo valves and six control actuators are mounted on a common manifold and powered by fluid or hot gases. The simplified "printed circuit" system of integral passageways within the manifold eliminates all external plumbing and leakage.

The acceleration switching servo valves provide positive control of spool velocity, thereby achieving greater resolution, reliability and response even at extreme temperatures.

Easily installed and removed as a complete, interchangeable unit, acceptance testing of this compact system can be accomplished prior to missile installation. Suggested applications are: missile surface controls, jetavator controls, and vector and nozzle steering controls. Your inquiries are invited.

Specifications

Actuator load (range)	*90 to 150 in. lbs.*
Electrical input (nominal)	*28 volts DC—10 Milliamperes*
Pressure range	*500 to 3000 psi*
Rated flow	*½ to 2 gpm*
Mounting	*Manifold*
External leakage	*None*
Proof Pressure	*4500 psi*
Burst Pressure	*7500 psi*
Temperature operating range	
Fluid	*-65°F to 450°F*
Ambient	*-65°F to 750°F*
System filtration	*10 microns*

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Circle No. 15 on Subscriber Service Card.

Cavitation Detector Aids Ground Testing

Failure in fuel regulation system may be cut by new electronic instrument

by Richard Van Osten

The AiResearch Manufacturing Division of the Garrett Corp. has developed a cavitation detector for incorporation in a missile ground-test system, or a flight test vehicle.

One of the problems encountered in liquid-propellant rocket engine systems is an instability of power output due to inconsistent fuel-oxidizer mixtures. A good portion of the mixture ratio deviation may be traced to cavitation in the fuel and/or the oxidizer system.

Cavitation is a well-known phenomenon that occurs with rapid evaporation of a liquid in local areas where static pressure is less than vapor pressure. Areas subject to this condition are usually those with steep pressure gradients such as valves, fittings or other points where abrupt changes of cross-sectional area or flow direction occur. The problem has been somewhat complicated by a lack of instrumentation required to determine the existence, location and magnitude of cavitation in a fluid flow.

- **Components**—Three basic elements make up the instrument: a sensing grid; an electronic control circuit; and an indicating and/or recording unit.

The sensing unit is an insulating support structure containing a series of metallic sensing grids in the liquid stream. The grids are designed as high-speed, low pressure drop hydrofoils. The hydrofoil shape was chosen to minimize any possibility of incipient cavitation being created by the grids themselves.

When tied into the electronic control circuit, the sensing grids are capable of detecting the passage of any single bubble or group of bubbles without regard to the diameter or complexity of the bubble pattern. In laboratory tests, bubbles no larger than 0.050-in. have been detected with ease in a 6-in. diameter line. Foreign matter, such as sand particles, may also be detected easily.

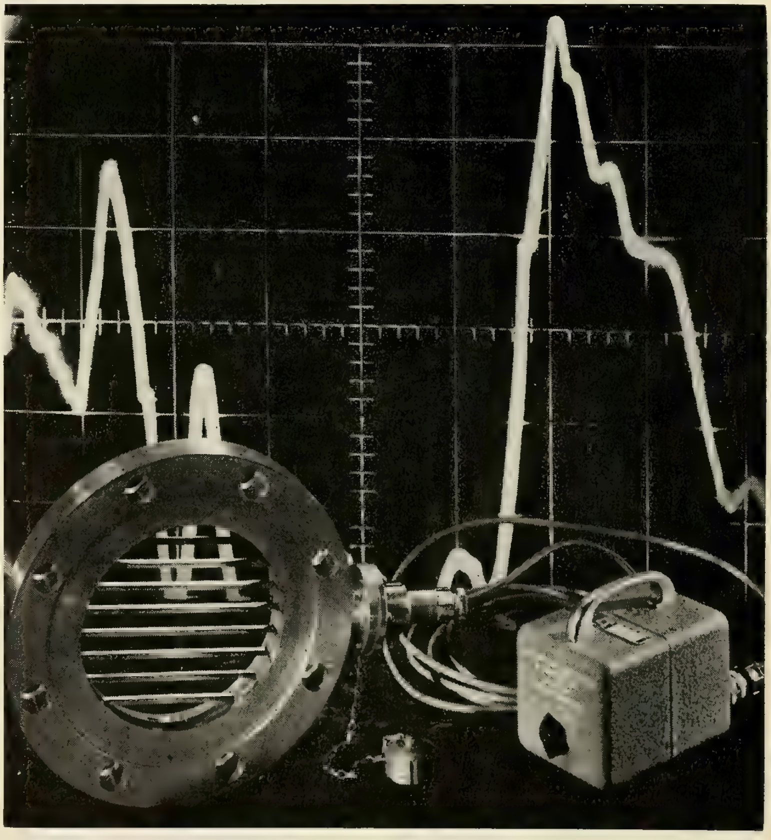
The relationship of the hydrodynamic center of pressure to the CG of the sensing grids results in an extremely high "flutter speed." This also minimizes any possibility of fluid flow exciting unstable grid vibration and furnishes an inherent damping characteristic within the unit.

The electronic control unit is designed with transistorized circuits, as well as a self-contained power source and miniature components. Output from the control unit may be furnished as an input to a conventional cathode ray oscilloscope and/or a conventional type electronic recorder. Flow characteristics may be indicated directly on the scope or on a recorder tape. There are additional circuits under development, which will apply the output to the control circuit of a servo loop of regulating equipment.

Indicating and recording units for use with the system are normally commercially available and require only nominal modification to be used with the detector.

The device is capable of reading out turbulence in flow as well as cavitation. Its output may also be converted to telemetry signals for airborne use or to a firing circuit, such as for rocket booster ejection.

Because there may be some applications in which the sensing grid is either impractical or even impossible to install, a ring-type sensor has been developed. In this case, the ring is flush with the inside wall of the flow tube, but the balance of the equipment is essentially identical to that used with the grid sensor.



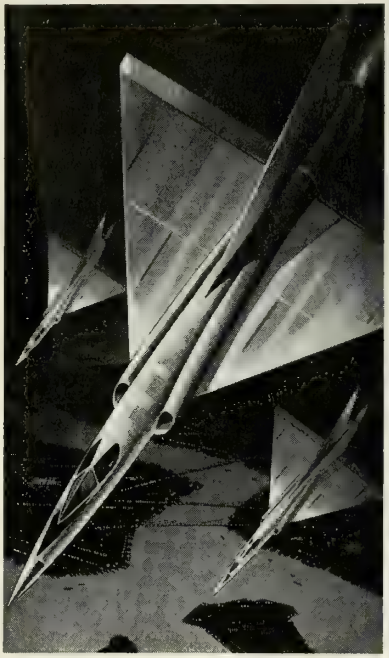
EFFECTS OF CAVITATION shown on chart produced by detector.

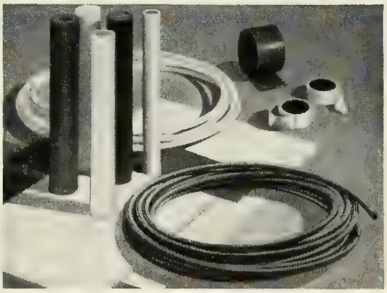
Insure added safety and efficiency with new R/M TEFLON* spiral cover for hose and cable

Raybestos-Manhattan has developed a "Teflon" spiral cover for hose and cable similar in principle to the cover on your telephone handset wire. It is nonwicking and has exceptional resistance to abrasion and very high temperatures. It is especially desirable where hose or cable passes through a firewall. Overlapping construction permits lengthening the spiral without uncovering the hose or cable. Diameters are easily altered by twisting.

Aircraft, missiles and rocket applications of "Teflon" are numerous. The early advent of others is indicated by modern research and development, especially in the production of "Teflon" custom-machined parts, which in certain situations are superior to those of any other material. R/M has complete facilities for machining "Teflon" parts to your specifications, with very close tolerances and rigid quality controls.

For more information, literature, and sales and engineering assistance, contact your nearest R/M district office listed below or write direct to Plastic Products Division, Manheim.





Other R/M "Teflon" products for the aviation, missiles and rockets industries: stainless steel wire braid covered thin-wall "Teflon" hose, rods, sheets, tubes and tape; rods, tubes and sheets in certified and stress-relieved grades (X-ray films for sheets and rods are also available); and centerless ground rods held to very close tolerances.

* *A Du Pont trademark*

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Brake Blocks • Clutch Facings • Laundry Pads and Covers • Industrial Adhesives • Bowling Balls

Circle No. 30 on Subscriber Service Card.

Missile Guidelines

Manufacturers Get Tips On Government Requirements

The Office of the Director of Guided Missiles for the Defense Department has set down a list of guidelines for manufacturers seeking missile work. In determining whether missile contracts would be either attractive or unattractive, the Office suggests these "special factors" should be taken into consideration:

"Missiles utilize almost every science and technology to the maximum of our knowledge and skill.

"Missiles demand high, uniform and repetitive quality.

"The environment criteria is much more severe than for conventional weapons.

"Missile tolerances are generally an order of magnitude 10 or more times more exacting than the weapons they replace.

"The materials used, the tolerances and the quality establish peculiar manufacturing needs.

"The complexity of both the missile and its operating system is generally of the highest order.

"We strive for infallibility-assurance of reliability.

"We have found it justified to pay for premium quality and workmanship when it assures high operability and reliability of the missile and its system.

"There is a high single shot-cost—and high single shot loss in case of flight failure.

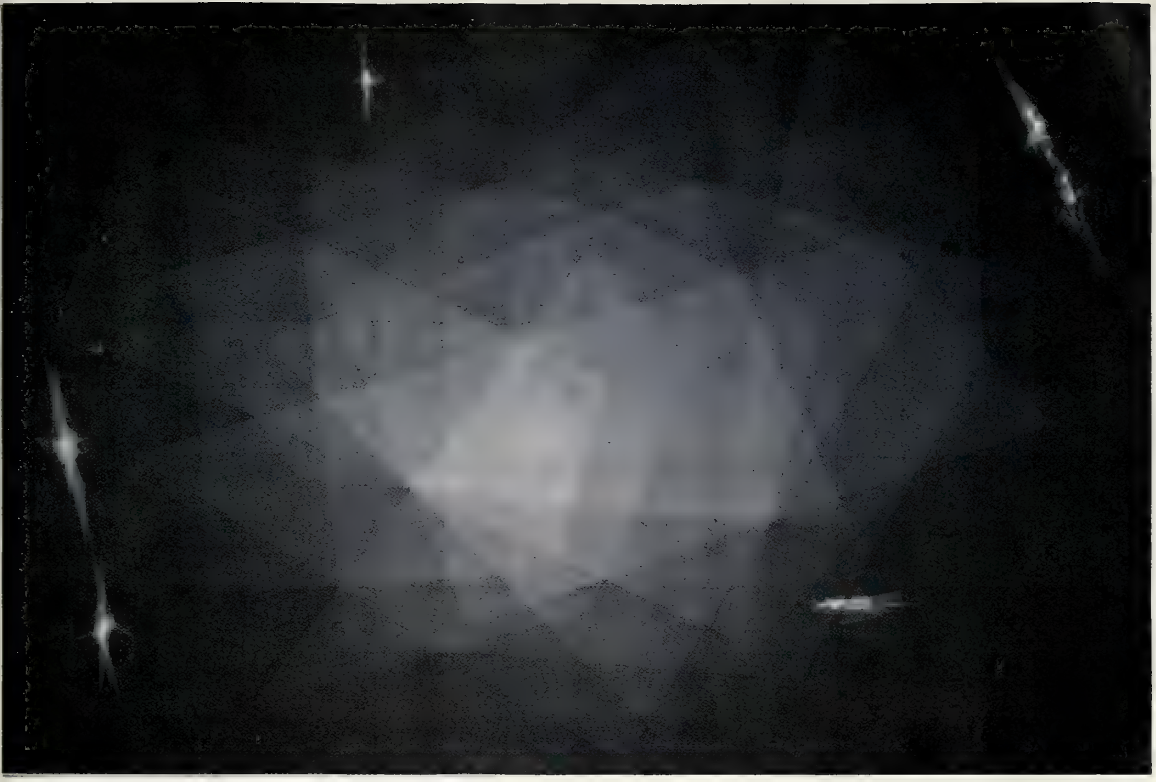
"Because of the very rapid advance in the technical state of the art, we have a high obsolescence rate-technical growth frequently exceeding prediction.

"We must build shelf life, operability and preventative maintenance into the weapon to minimize demands on military manpower."

These guidelines were spelled out by Robert J. Gutheim, head of the division of planning in an address before the New York State Defense Procurement Conference at Utica, N.Y.

He said the complexity of missiles and missile systems "result in the prime contractor having relatively few of the array of skills and manufacturing capabilities needed for the complete job."

The prime has the ability to manage and the responsibility of breaking down the overall job into segments "that can be delegated and subcontracted to other organizations for design or manufacture." In turn, the prime contractor then "knits the output of all the supporting organizations into the product we need."



"FORCES OF NATURE," another in a collection of paintings by Simpson-Middleman, two talented artists who find in the natural sciences the subject matter for their contemporary expressions. Courtesy John Heller Gallery, Inc.

Conquest of space

Boeing has geared its facilities, research and manpower resources to meet the complex technological requirements of the space age. The Systems Management Office, for example, has responsibility for the over-all management as well as the technical research and development activities in advanced flight technology, electro-magnetics and support systems leading to operational space weapon systems.

The Boeing Scientific Research Laboratories have been established to develop new, fundamental knowledge at the frontiers of science. They provide the environment of scientific freedom necessary to the attainment of this objective. Areas of investigation include, but are not limited to, hypersonics, energy conversion, solid state physics, magneto-hydrodynamics, nuclear and plasma physics, advanced propulsion systems, and the effects of high temperatures on structures and materials.

Boeing engineers and scientists are currently at work on an Air Force assignment for Phase I development of Dyna-Soar, a manned space vehicle which will orbit at speeds approaching 18,000 miles an hour and be capable of re-entry and normal landing.

Dyna-Soar and other advanced projects at Boeing offer exceptional space-age opportunities to engineers and scientists of all categories. Drop a note now to Mr. Stanley M. Little, Department R-80, Boeing Airplane Company, Seattle 24, Washington.

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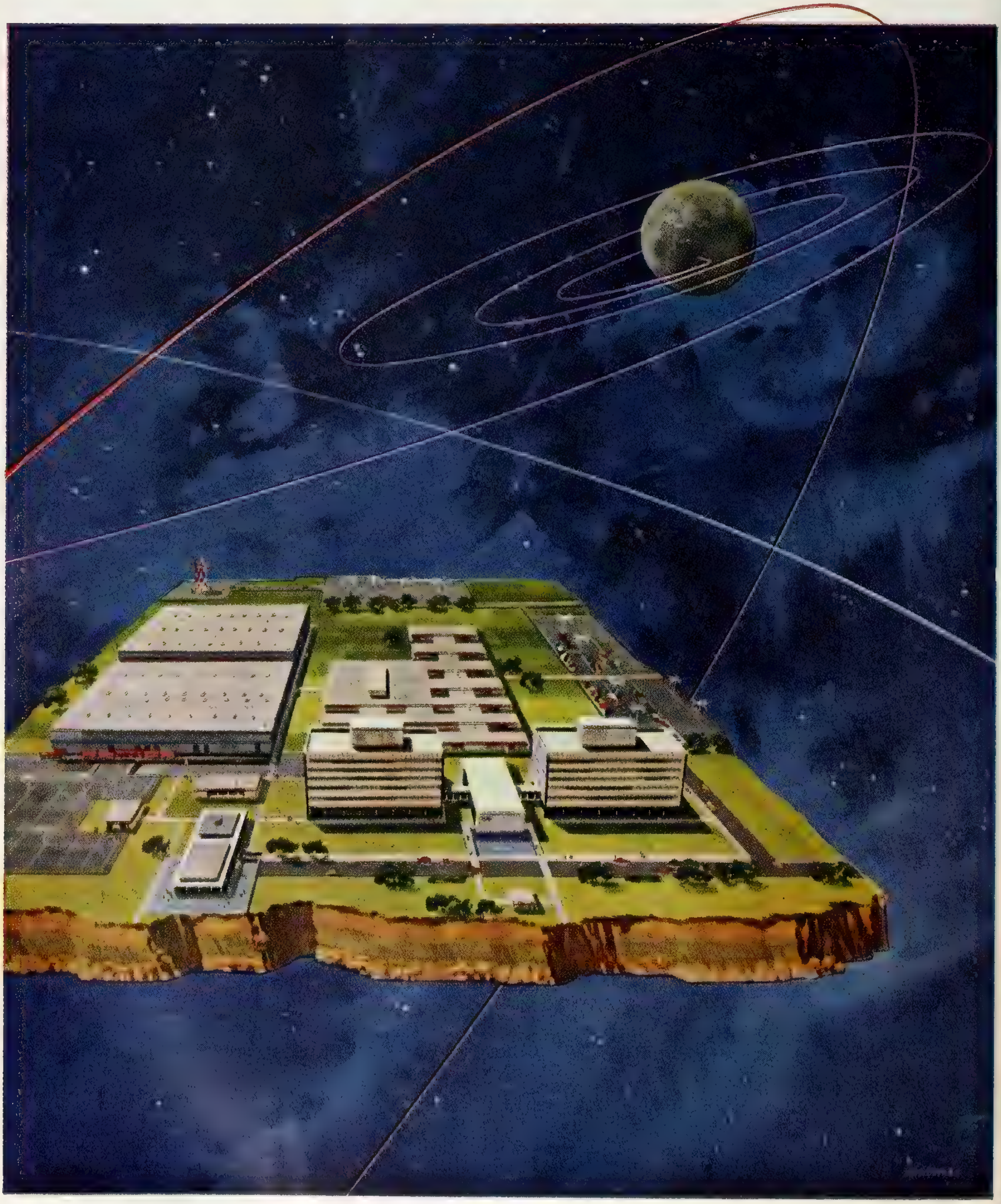


Ozone Taking Back Seat In Use As U.S. Rocket Fuel?

Indications Are That Ozone Will Not Be Ready For At Least Five Years

by **Alfred J. Zaehringer**

CHICAGO, ILL.—Talks with Armour Research Foundation and other sources definitely leave the impression that the U.S. has taken a back seat in the utilization of ozone for rocket propulsion.

Armour's pioneering work with high concentration liquid ozone dates back at least ten years, but is still at an early level—not much beyond the laboratory level—and probably it will be at least five years before liquid ozone can be successfully applied in a small rocket engine. In contrast, liquid fluorine is being tested in medium thrust rocket engines by at least three agencies.

Liquid fluorine is stable. Despite encouraging experiments at Armour and elsewhere, 100% liquid ozone still has not been stabilized enough for reliable rocket runs. Meanwhile, liquid fluorine is becoming a standard production item in the chemical industry, leaving ozone in the microlab level. Ozone stabilization, though, looks feasible, and it is here that additives may provide the breakthrough. Sulfur compounds have been mentioned as stabilizers.

An ozone research committee has been formed, and will possibly advise ARPA and NASA what has to be done and how much it will cost to successfully stabilize ozone and start rocket engine tests. That point, however, has not been reached.

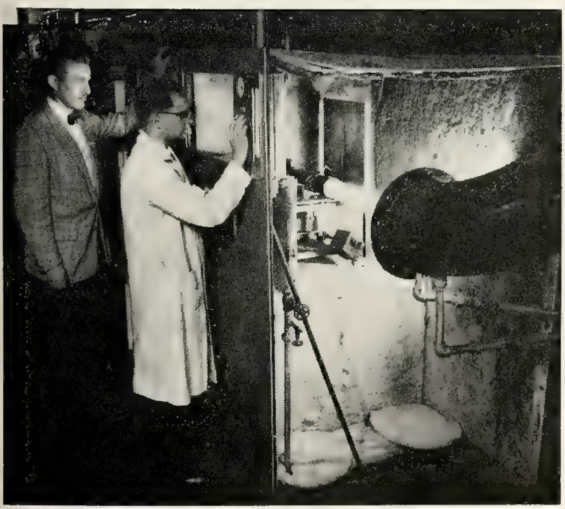
Meanwhile, the U.S. ozone program is left hanging. Only a few thousand dollars are now going into ozone propulsion research. It is barely enough to keep the few ozone research groups intact.

• Soviets years ahead—Clark E. Thorp, manager of ARF's Chemical & Chemical Engineering Department, points out that the Soviets are investing heavily in ozone propulsion. A great deal of Red ozone literature has been openly published, and it is suspected that much more lies in the realm of classification. Some estimates of USSR ozone effort place the figure in millions of rubles.

There is evidence that the Russians have successfully stabilized ozone for employment in new liquid missiles and manned rocket aircraft. Whether the Reds are using 100% liquid ozone, or whether they are merely using it in concentrations of 30-40% with liquid oxygen, is a matter of conjecture. Either way, it places the Red ozone efforts some 10 years ahead of the U.S. More significantly, it means that the ultra-energy Red missiles can be loaded at launching pad from portable LOX-LOZ generators.

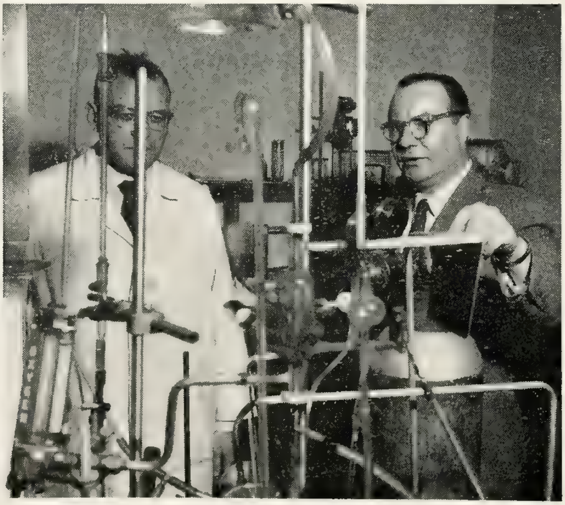
• Fluorine disadvantages—When the U.S. finishes applying fluorine to its rockets, it will be faced with a huge logistical problem—manufacturing fluorine in the U.S. and shipping it overseas to missile bases. Ozone can be manufactured from gaseous oxygen, which is available the world over.

An even more serious consequence is the toxic exhaust of fluorine. Chemical "fallout" from the firing of a flurine ICBM or IRBM can cause serious health hazards in the form of HF to humans, animals, and even plants. By contrast, combustion of



Armour

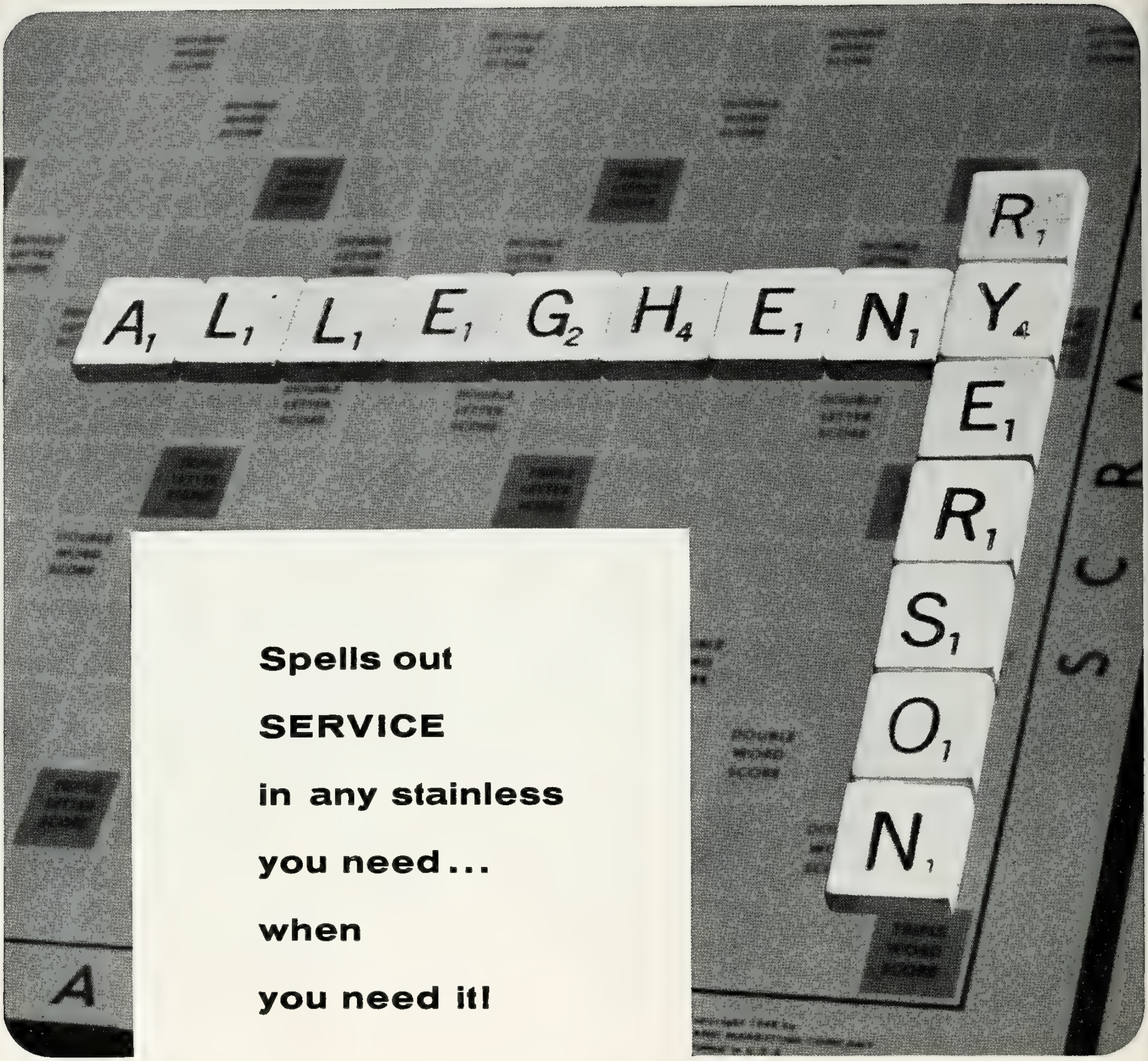
HOT AND BRIGHT, liquid ozone burns in combustion test at Armour Foundation Laboratories.



Armour

LABORATORY HANDLING of new fuel is a touchy, difficult problem that must be carefully monitored.

Experience—*the extra alloy in* **Allegheny Stainless**



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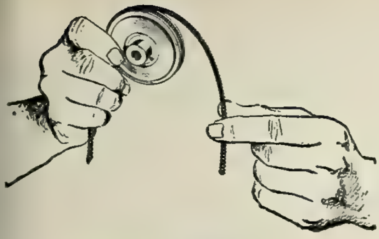

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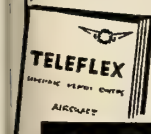


. . . ozone

LOZ with the hydrocarbons produces ordinary water.

Although Thorp, a top ozone expert, admits some of these facts, he is confident that ozone will follow the same growth and safety patterns shown by other high energy compounds that have become common items of chemical production.

• **Solid ozone?**—Ozone may take an entirely new approach for competing with fluorine. Armour recently proposed to AFOSR that work start on an old principle of stabilizing explosives—that of "dead pressing".

Deadpressing is a term used in the explosives field to indicate a change that takes place when a compound is highly compressed. Some explosives will not detonate after such compression, but will merely burn.

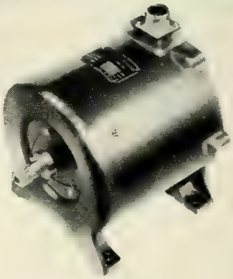
Though details were not given by Armour, here is how ozone might be used in a solid propellant: after compression, the solid ozone might be mixed with a fuel-binder to form a cold solid substance. The binder, acting in tension, would keep the ozone compressed. To use this "cryogenic solid," the mass would have to be kept refrigerated—say at about –195°C. Though this is cold, it is much "warmer" than the few degrees K temperatures needed to stabilize free radicals.

• **Ozonide oxidizer**—Another ozone area that Armour doesn't wish to comment on are the ozonides. There have been numerous references in literature (including Armour's) to the organic ozonides. Surprisingly enough, such ozonides are remarkably stable.

This is probably the area where ozone can be used—as replacement of the age-old standard inorganic oxidizers (nitrates, perchlorates) with a molecule that combines both oxidizer (ozone) and fuel (a metal or organic radical). Ozonides might make possible an over 325 sec homogeneous solid propellant.

There is every indication that the Soviets have scooped us here, too. Much European and Russian work has been openly reported on metal and organic ozonides. The Reds may have been the first to realize that, to improve the performance of solid propellants, you have to not only work on the fuel, but on the oxidizer.

Meanwhile, Armour has quietly set up a static test facility some 50 miles west of Chicago. Fluorine has been fired here, but whether ozone (solid or liquid) will get into a rocket engine is now nebulous.



PERMANENT MAGNET ALTERNATORS AND INVERTERS

Extreme Reliability • High Efficiency
Static Voltage Regulation • High Speed

The superior advantages of Pesco produced permanent magnet alternators and inverters are responsible for their use in many of the major missiles and supersonic aircraft. By utilizing a radial air gap permanent magnet rotating field, all brushes and slip rings are eliminated, thus reducing radio interference and explosion danger. Present models range in size from 25 VA to 12 KVA output at speeds of 3000 to 48,000 R.P.M. Pesco's creative research, engineering and production group offer a completely integrated facility for your power supply needs. Please write for full technical data to

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PESCO PRODUCTS DIVISION
Borg-Warner Corporation
3310 Vanowen Street
Burbank, California

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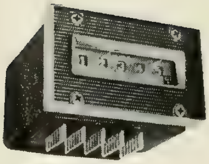
COMPARE FEATURES  AND YOU WILL SPECIFY NEURON!

Neuron High-Speed Electromechanical Counter, now manufactured by the Data Instruments Division of Telecomputing Corporation, is the same highly reliable Neuron counter which has enjoyed wide acceptance in a great variety of totalizing applications. ■ Prompt Delivery—assured by Telecomputing's resources and facilities. ■ High Speed—counting rate to 40 per second. ■ Precision—cannot double index. Full count registered on leading edge of input pulse. ■ Add and Subtract—accepts random add and subtract pulses. ■ Instant Reset—mechanical or electrical. ■ Environmental Capabilities—balanced moving elements provide exceptional resistance to vibration and shock. ■ Switch and visual readout. ■ Designed for panel mounting. ■ Specify Neuron for the solution of tabulating problems that ordinary counters cannot solve. For complete information, write, wire, phone, DATA INSTRUMENTS DIV. ■ TELECOMPUTING CORP., 12838 Saticoy St., N. Hollywood, Cal.

−

the only electromechanical
totalizer with
switch-readout capable of
adding and subtracting

+

Circle No. 16 on Subscriber Service Card.

world astronautics

by Frederick C. Durant III

The capabilities of man's physical senses in space, as compared to terrestrial functioning, will not be determined finally until man is in satellite flight. According to space medical authorities, X-15 flights and manned ballistic flights of a few minutes duration will not provide sufficient data to predict man's physical capabilities in weightless condition for hours or days.

J. C. Guignard, M.B., ChB., writing in the July issue of The British Interplanetary Society's SPACEFLIGHT, reviews some of the physiological problems man would face in the manual assembly of prefabricated space stations. This thoughtful piece is recommended to those who would have man locating, moving, and fastening innumerable pieces of "tinkertoy" in orbit.

Man will, eventually, assemble space stations, but at first he will handle only the smallest number of simple components. An interesting appendix to this article illustrates with diagrams the problems of discrimination and depth perception of objects in space under conditions of objects (a.) in planetary shadow, (b.) of high albedo in full sunlight and (c.) against a planetary segment. It is suggested that a system using consecutively placed contoured lights might be used to aid in determining attitude, size, distance and displacement of bodies in space.

According to Krafft Ehricke, the problem of timing is acute in the launching and programming of thrust in earth-lunar trajectories. It is greater in launchings from higher latitudes.

Furthermore, the farther a launching site is away from the equator the longer the interval is between possible launchings to the Moon. The reason for this is that the Moon lies in an orbit whose plane passes close to the equator. Launching from the higher latitudes causes the vehicle to approach the lunar orbital path at higher angles. Such flight paths result in greater critical timing and vehicle velocity.

The above conditions are bad enough for a one-way mission to the Moon. On circumlunar shots, however, northerly launching points become even more undesirable. The U.S.S.R., for example, cannot fire a circumlunar vehicle from within their borders unless (a.) the vehicle remains at a great distance from the Moon (scientifically undesirable) or, (b.) considerably more energy is stored in the vehicle for powered maneuvers. Thus the U.S. currently has a major advantage over the U.S.S.R. by having a lunar launching site appreciably nearer the equator.

A rocket launching system which utilizes atmospheric oxygen from take-off to 100,000 feet has a potential design weight advantage. Numerous concepts have been put forward including aircraft as launchers and clustered turbojet engines. Another favorite is the "ram rocket" power plant in which a rocket motor is operated over-rich and the rocket jet exhausts into a ramjet after-burner where combustion is continued. Experiment, Inc. and Aerojet-General have been studying ram rockets for several years.

Anhydrous (water-free) hydrazine in immense quantities is an apparent requirement for large space-age rocket launching vehicles. Dilute water-hydrazine mixtures are cheap; the problem—and cost—is in the removal of the water. The use of chemical agents (such as alkaline earth metal hydroxides) for dehydration give low yields while the application of these metals in elementary form (such as sodium amide) is hazardous because of the possible formation of explosive compounds. Mere evaporation leads to azeotropic distillation of low concentration, with water and hydrazine both boiling off at the same rate.

H. Bock of University of Munich published a method whereby appreciable quantities of concentrated hydrazine have been obtained in his German laboratory. The final stage of the process is rectification at 720 Torr in a Dewer-like vessel under an atmosphere of nitrogen.

FOR THE AIR FORCE'S ATLAS
TITANIUM FOR WEIGHT REDUCTION

(Official U. S. Air Force Photograph)

Our metallurgists and engineers will be glad to work with your personnel in developing the most advantageous use of Republic Stainless Steels, Alloy Steels, and Titanium. There's no obligation. Write Republic Steel, Dept. MR-6078, 1441 Republic Building, Cleveland 1, Ohio

REPUBLIC STEEL

World's Largest Producer of Missile Metals—Titanium, Stainless Steel, and Alloy Steel

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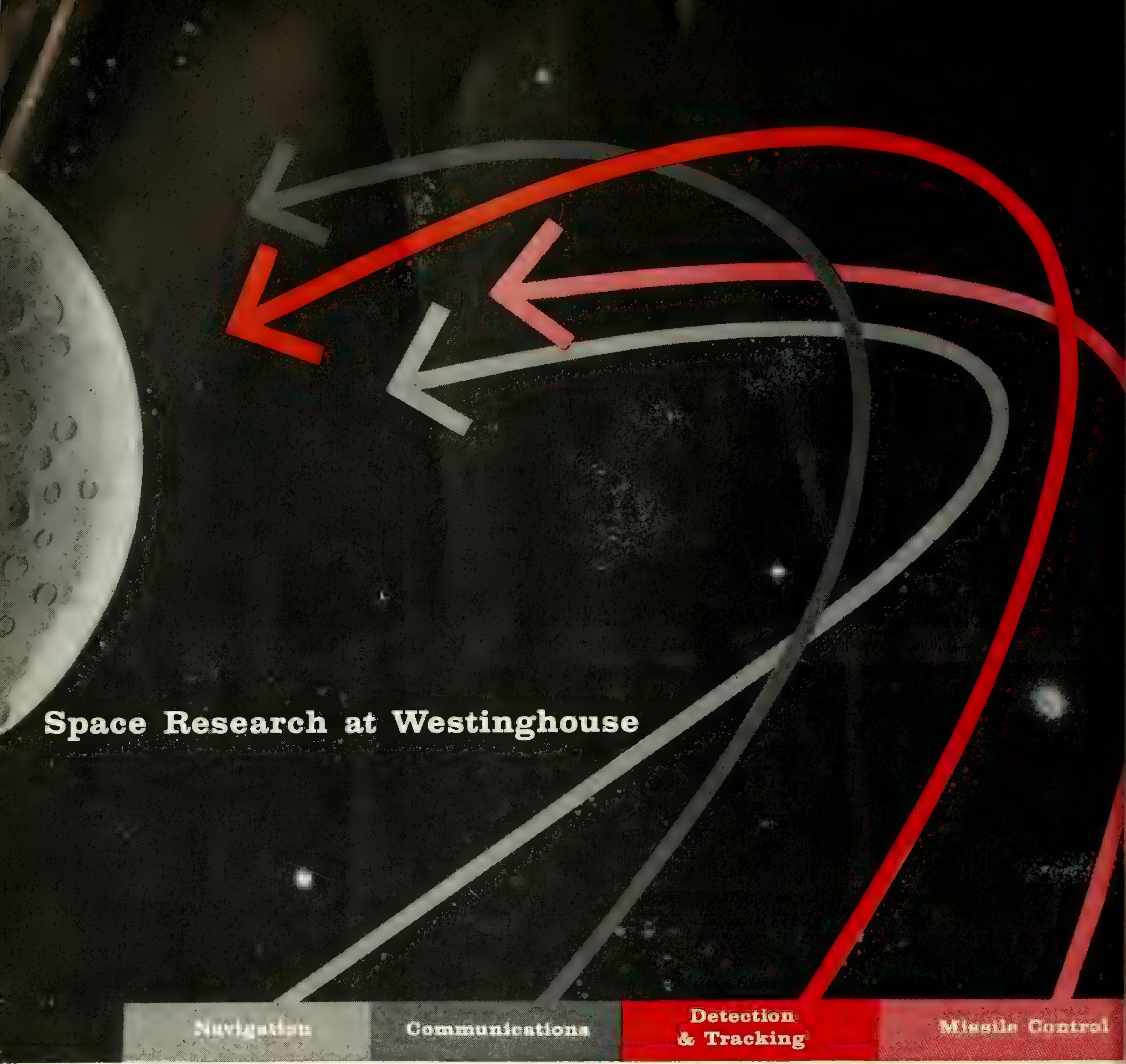


to make the moon the free world's high ground

The skills and talents of the Westinghouse Electronics Division have been directed to research and development in these critical fields to help find the answers to man's next major space accomplishment . . . reaching the moon . . . and beyond.

These activities are typical of the Westinghouse projects for present and future military applications. They are facets of the Electronics Division's abilities and capabilities to design, develop and produce systems and sub-systems for the conquest of space.

Westinghouse Electronics Division, P.O. Box 746, Baltimore 3, Md.

J-02304

WESTINGHOUSE ELECTRONICS DIVISION

MILITARY SYSTEMS

RADAR
COMMUNICATIONS
MISSILE CONTROL
DATA PROCESSING
AND DISPLAY

YOU CAN BE **SURE**...IF IT'S Westinghouse

Circle No. 17 on Subscriber Service Card.

Photosynthesis Seen Answer to Space Life

GROTON, CONN.—Photosynthesis, which replenishes life-sustaining oxygen in an endless cycle on earth, may enable man to travel in outer space for unlimited periods of time, it was reported here to the first international symposium on submarine and space medicine.

The feasibility of growing algae in nuclear submarines and space ships was outlined by T. A. Gaucher of General Dynamics Corporation's Electric Boat Division. GD's research was conducted in cooperation with Dean Burk and George Hobby of the National Institutes of Health.

Gaucher declared that a new strain of algae has been developed which increases 1,000 times a day compared to only 8 times a day in previously employed algae.

The new method, using very dense plant cultures of fast acting algae irradicated with extremely intense light, has reduced the volume of algae required to one-twentieth of the most recently published estimates.

The noxious carbon dioxide respirated by men is removed from the closed atmosphere of sealed containers in the same manner that green plants do on earth. In addition, the report stated that the algae also produce large quantities of food material rich in protein and vitamins.

A small source of light energy to serve as an artificial sun many times the intensity of the brightest sunlight was developed for the method by the General Electric Company.

Cultures of the new algae strain, discovered by C. Sorokin at the University of Texas a few years ago, are pumped very rapidly past the light, which is not much bigger than a pencil. This provides rapid stirring to use the well established advantage of intermittent illumination. The alternate periods of high intensity light flashes are followed by dark rest periods for recovery.

Philco Forms Group for Advanced Weapon Systems

Philco Corporation's Government and Industrial Division has announced the formation of an advanced weapon systems (AWS) group. The objective of the group will be to study and formulate new and advanced weapons systems to meet future military requirements.

The group will be headed by Hayden N. Ringer who has been with Philco since 1945. Up to now, Ringer has been in charge of the Government and Industrial Division's missile fuze research, development and production engineering for the *Terrier, Talos, Tartar, Sergeant, Corporal, Little John,* and *Falcon* missiles.

Biggest Environmental Unit Built for Testing

Tenney Engineering Co. of Union, New Jersey recently completed construction of what it says is the world's largest environmental chamber, for McDonnell Aircraft.

The unit is 18 feet square and 42 feet deep, weighs 125 tons and has a temperature range of minus 100 degrees to plus 1200 degrees F through altitudes to 150,000 feet.

Effective workspace in the chamber is 14 feet square by 35 feet deep. Within the area, McDonnell can simulate ram airflows up to 100 lbs/min. at 75,000 feet at various temperatures. It is also possible to dissipate a live heat load equivalent to 30 hp at altitude conditions while maintaining a temperature of minus 80 degrees fahrenheit.

The unit is equipped with four viewing windows and additional guarded openings for electrical and hydraulic pressure lines. Walls are two feet thick and the interior is stainless steel, treated to withstand the high operating temperatures.

U.S.-British Firms Join to Produce Control System

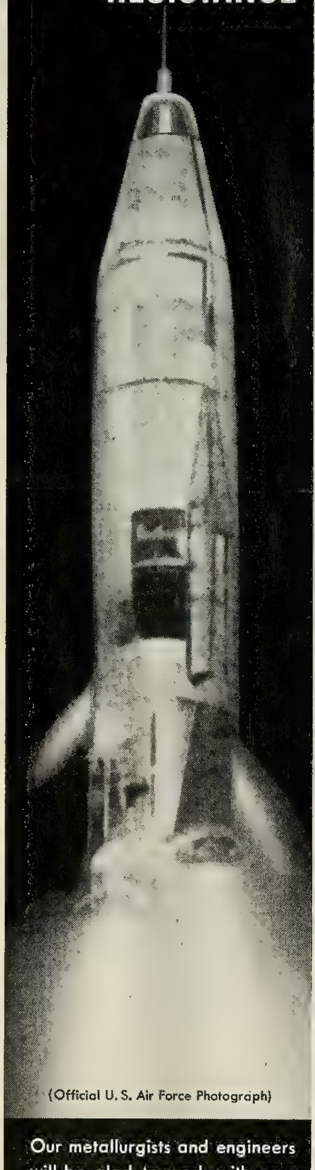
Consolidated Electrodynamics Corp. of Pasadena, and The Elliott-Automation Ltd., of London, England, last week announced an exclusive licensing agreement, under which the British firm will manufacture and market analytical and control instruments of CEC design.

Under the agreement, the English firm will market the licensed instruments in all countries of the British Commonwealth, except Canada. It may also act as supplier to a CEC subsidiary in Germany.

The instruments included in the agreement are analytical and process-control MAS spectrometers, chromatographers, moisture monitors, refractometers, and oxygen analyzers.

(m/e News continues on p. 41)

FOR THE AIR FORCE'S ATLAS
STAINLESS STEEL
FOR HEAT
RESISTANCE



(Official U.S. Air Force Photograph)

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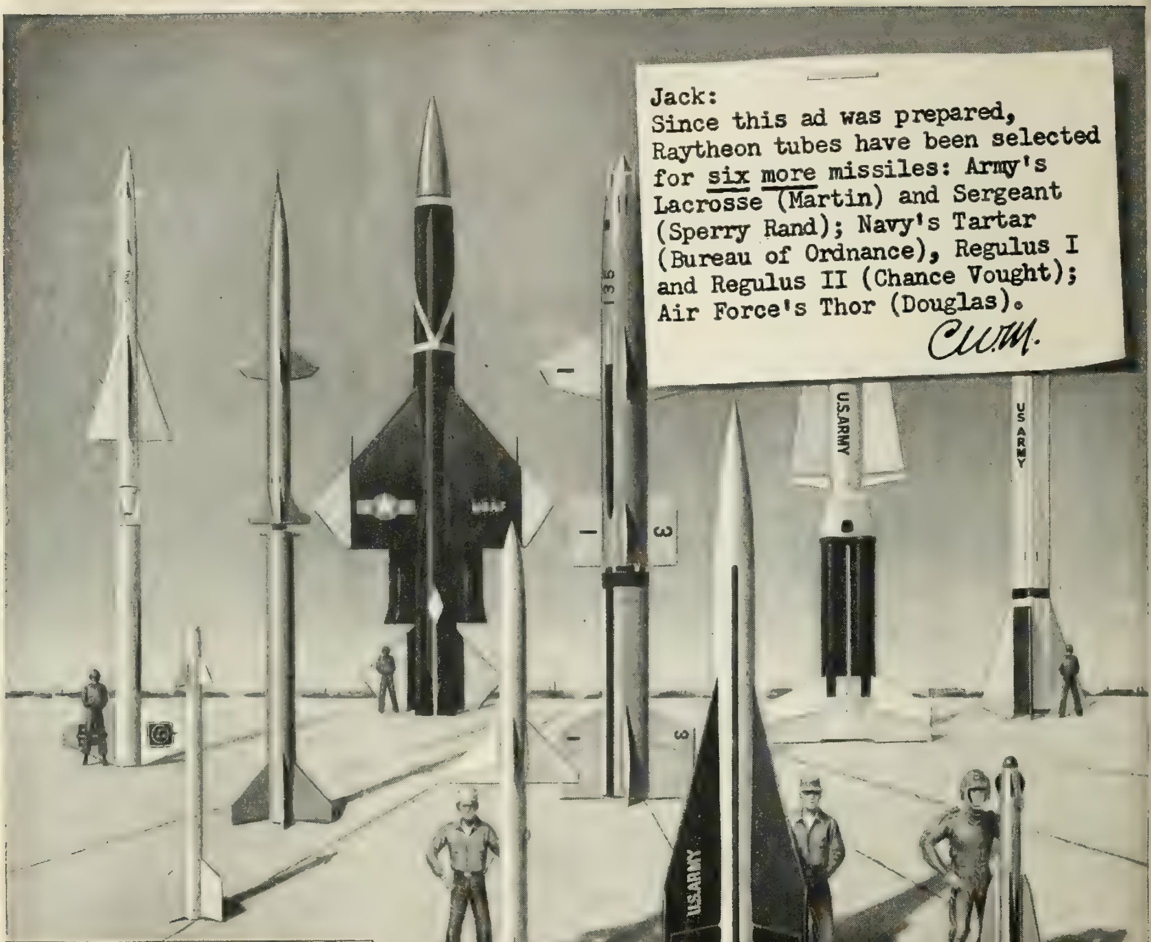
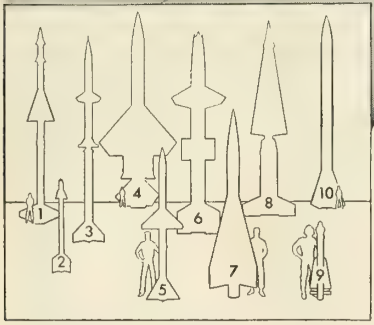


Jack:
Since this ad was prepared, Raytheon tubes have been selected for six more missiles: Army's Lacrosse (Martin) and Sergeant (Sperry Rand); Navy's Tartar (Bureau of Ordnance), Regulus I and Regulus II (Chance Vought); Air Force's Thor (Douglas).
CWM.



1. **Nike Ajax.** Army. Ground-to-air. Prime contractor: Western Electric.
2. **Sidewinder.** Navy. Air-to-air. Prime contractors: Philco; General Electric.
3. **Terrier.** Navy. Surface-to-air. Prime contractor: Convair.
4. **Bomarc.** Air Force. Ground-to-air. Prime contractor: Boeing.
5. **Sparrow III.** Navy. Air-to-air. Prime contractor: Raytheon.
6. **Talos.** Navy. Surface-to-air. Prime contractor: Bendix.
7. **Hawk.** Army and Marine Corps. Ground-to-air. Prime contractor: Raytheon.
8. **Nike Hercules.** Army. Ground-to-air. Prime contractor: Western Electric.
9. **Falcon.** Air Force. Air-to-air. Prime contractor: Hughes Aircraft.
10. **Corporal.** Army. Ground-to-ground. Prime contractors: Firestone; Gilfillan.

10 MAJOR U. S. MISSILES RELY ON RAYTHEON TUBES

Crushing acceleration and searing heat must be endured by the electronic tubes in guided missiles. Even under these grueling conditions, tiny Raytheon tubes produce guidance impulses with steadfast *reliability*. This reliability is achieved through capable engineering and painstaking manufacturing and testing techniques.

The choice of Raytheon Reliable subminiature tubes for use in these 10 missiles is another example of how the 31,000 men and women of Raytheon are contributing to the nation's security.

RAYTHEON

Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY, Waltham, Mass.

astrionics

by Raymond M. Nolan

An indication that the computer industry is really coming of age is the offer by Remington Rand to sell a number of traded-in Univacs. The computers, among the earliest ones built, carry a price tag in the vicinity of one-half the original $1 million cost.

The Nortronics division of Northrop has come up with what it claims is the first spherical-type airflow direction and pitot pressure sensor. Called the "Q" ball, it measures angle of attack, sideslip angle and dynamic pressure. One use could be for achievement of optimum reentry angle for *Dyna-Soar* type vehicles.

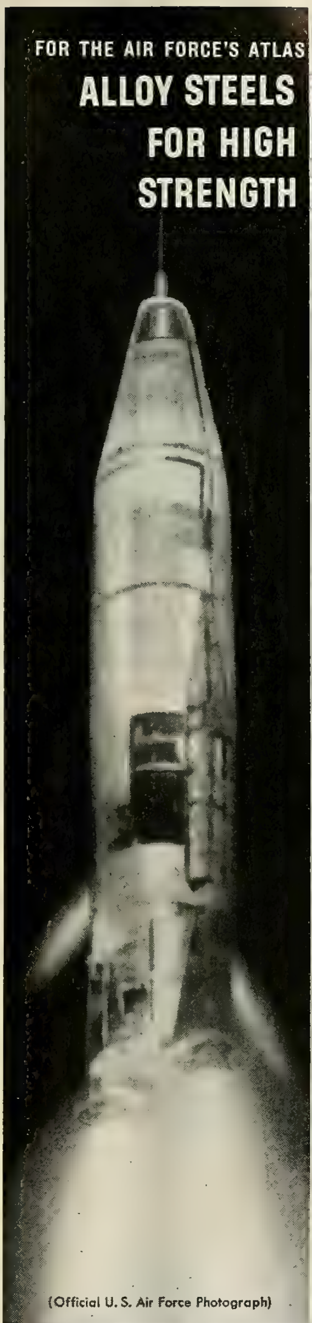
Sperry Gyroscope recently ran through first tests of its inflatable radome, developed to house the MPS-21 Tactical Early Warning Radar. The complete system, developed for battlefield portability, can be assembled and operating in something like two hours. The miniaturized radar set has superimposed paraboloidal-shaped dishes on the antenna, combining search and height-finding functions by measuring return echoes picked up by the vertical and slant-beam reflectors in relationship to the angle between the two and the time between echo "hits" on them.

A unique approach to accelerometer development was described recently by the research department of a major manufacturer. The method, which evidently never got beyond the laboratory stage, measured deflections of small "pellets" of liquid impinging on a target. Accelerations caused the pellets to deviate from the "bullseye" and the amount of deviation was convertible to a measurement of force and direction. Some thought was also given to an analogous system using electrons in place of the fluid, but discarded because the parameters to be measured were so small in relation to normal power supply preturbations.

It's sometimes hard to tell who will turn up in the missile business these days. Paramount Pictures recently announced the election of three new vice-presidents in the Autometric Corporation, a subsidiary of Paramount. Autometric is an R&D firm working in the fields of electronics, data reduction, and reconnaissance analysis. One of the vice presidents is Dr. Ulrich K. Heidelauf, formerly a special consultant to WADO on intelligence and reconnaissance systems.

Interstate Electronics Company continues to expand with the addition of 15,000 sq. ft. to its Anaheim facility. Only in business 31 months, the firm experienced much of its expansion right in the middle of the DOD stretchout, because of its heavy involvement in the *Polaris* program. One neat device developed by Interstate was a super-efficient filter used by Aberdeen Proving Ground to track *Explorer* satellites. The filter reportedly allowed tracking through a full quarter-orbit using a conventional precision receiver.

Electronic Industries Association's latest Specification for Military Components is SMC-2 for insulated, high-temperature electrical wire. The specs, which are formulated by EIA's Engineering Department Committees, are approved by EIA industry members. For further information, write to EIA Engineering Office, 11 West 42nd St., New York 36.



FOR THE AIR FORCE'S ATLAS
ALLOY STEELS
FOR HIGH
STRENGTH

(Official U. S. Air Force Photograph)

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World's Largest Producer of Missile Metals—Titanium, Stainless Steel, and Alloy Steel

REPUBLIC STEEL

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Robertshaw delivers More Reliable Electronic Cable Fast and for Less Cost

R-F Designed Planetary Cabler

Connector Wiring

As the count-downs become more complex, the need for more reliable electronic cable systems become compelling. Robertshaw's unique approach to the fabrication of custom electronic cable assures missile manufacturers of precision cable delivered on time, more economically.

At Robertshaw's integrated cable facility, leading cable designers and engineers have developed revolutionary new equipment and methods capable of fulfilling every conceivable cable requirement.

This is Cable Systematics. Designed to answer *your* cable problem. We invite you to inspect our facilities.

Write for Technical Bulletin, RF-5810

AERONAUTICAL AND INSTRUMENT DIVISION
Robertshaw-Fulton CONTROLS COMPANY
SANTA ANA FREEWAY AT EUCLID AVENUE • ANAHEIM, CALIFORNIA

Circle No. 36 on Subscriber Service Card.

GE Reorganizes MOSD Facilities

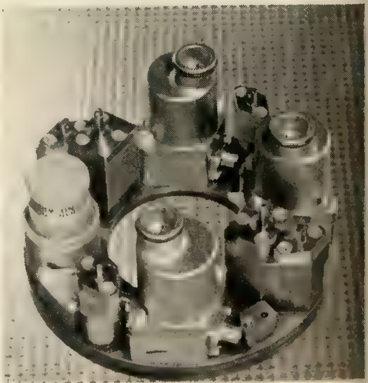
Reorganization within the Defense Electronics Division of General Electric is expected to relieve the Missile Ordnance Systems Department of responsibility for operations of the Ordnance Section, and to make MOSD talents and facilities available on advanced types of missiles and new projects.

MOSD has been redesignated the Missile and Space Vehicle Department. The former Ordnance section of MOSD has been established as a separate operating division of the Defense Electronics Division and renamed the Ordnance Department.

The Missile and Space Vehicle Department employs about 5,000 people, many of them engineers and scientists. It has applied research and development facilities at Philadelphia, and a missile production section in Burlington, Vermont. Field personnel are located at primary missile and space vehicle locations in the U.S. and overseas.

The Ordnance Department employs about 2,500 in development and manufacturing facilities at Pittsfield, Mass. This department is currently working on development of fire control and inertial guidance systems for the *Polaris*; development of shipboard handling and launching system for the *Talos*; and development and production of the *Mark* 73 fire control system and the *Mark* 43 torpedo for the Navy.

"Black Box" Hydraulic Servo Eases Repair



Los Angeles—Simplicity has been a prime factor in the design of an electro-hydraulic steering control system developed for missiles by the Garrett Corporation's AiResearch Manufacturing Division.

The system controls the positioning of steering surfaces, jet-avayors, jet engine exhaust areas, nozzle and vector steering controls. It converts low-level electronic signals from a missile's main guidance system into hydraulic forces which actuate directional control mechanisms.

A design feature is the use of "hydraulic printed circuits," analagous to electrical printed circuits. It combines manifolds and mounting structures in a series of integral passageways, eliminating all external plumbing and leakage.

The system's control elements are relatively insensitive to missile maneuvering accelerations and can stand at least 100 g force with no change in performance.

Modular design of the AiResearch unit helps reduce missile trouble, shooting to a simple process of tracing a difficulty to a major package. Quick replacement of the modular unit becomes the only delay at missile level, with detailed trouble-shooting accomplished almost entirely at specialized test locations.

Once the package is bench checked and calibrated as a complete unit, it can be installed in the missile without danger of making incorrect or leaky connections, or changing critical adjustments.

Missile Companies Discuss Merger

Preliminary discussions are underway between General Transistor Corporation, New York, and Barnes Engineering Company, Stamford, Conn., for a possible combination of the activities of the two companies. If the merger is agreed upon, it would be effected through the exchange of one share of General Transistor stock for each 3¾ Barnes stock.

Barnes Engineering Co. played an important role in the Army's recently completed *Operation Gaslight*, which involved the successful re-entry of a *Jupiter* nose cone. Barnes supplied scientists and other personnel for the experiments, and also developed special radiometers and a meteor-spectral camera.

Mack Truck Electronics Division Acquired by E.A.C.

The Electronics Division of Mack Trucks in Plainfield, New Jersey, which was discontinued on August 30th, 1958 has been acquired by the Electronic Assistance Corp. of Red Bank. Included in the acquisition are the manufacturing rights, tools, drawings, etc.

Robert Edwards, former general manager of Mack Electronics, becomes President of E.A.C. In addition most of the key personnel from the former

Major Southern California missile operation has
immediate openings
for qualified graduate engineers with experience in

Instrumentation Systems
with general knowledge of missile systems, including propulsion, guidance, structures and electrical systems.

Guidance Systems
Experienced in research and testing of practical hardware, and with mathematical background for systems analysis.

Flight Test
Background should qualify for planning and formulating entire flight test programs.

Aerodynamics
Must be able to analyze missile configuration to determine aerodynamic performance and stability and control characteristics.

Well paid jobs
for qualified people

Relocating expenses paid.

For information on these and other engineering positions, write:

Mr. H. B. Richards, Dept. 451
Missile Division
North American Aviation, Inc.
12214 Lakewood Blvd., Downey, California

electronics division have moved to the new company.

E.A.C. will continue to produce all the electronics equipment formerly manufactured by Mack. This includes radar and communications equipment for military use. Present contracts include the completion of Mack's obligations to the government and subcontracts from Lockheed Aircraft and the Signal Corps.

ITT to Show Weapons System at Dallas

International Telephone and Telegraph Corporation will make a presentation of a complete weapon system with its complex communication network at the Air Force Association's Air Power Panorama at the Dallas, Texas, Memorial Auditorium, September 25-28.

The sixty-foot exhibit will show a weapons system from the early research stages until it emerges as a fully operating unit. The exhibit will also illustrate ITT's role in the field of missile electronics and communications. By means of a stylized missile, illuminated and synchronized with a descriptive sound system, spectators will be able to observe where components or assemblies are used in a typical weapon.

ITT has been in the foreground of the missile business since 1945. Among its missile projects have been the development of airborne guidance equipment for the *Talos* and *Terrier* missiles; a new control system design for *Rascal*; the computing ground, air and tracking system for *Lacrosse*; the ground communications network feeding information to the *Atlas* ICBM.

Douglas Organizes Reliability Subdivision

Organization of a new sub-division to lend emphasis to the importance of reliability in its products was announced at the El Segundo Division of Douglas Aircraft Company.

In announcing the new sub-division, H. G. Hynd, Division Vice President-General Manager, disclosed the realignment of several other departments as well as the creation of a new department. W. L. (Lew) Whittier, former Chief Service Engineer, has been named Product Reliability Manager.

Hynd said that under the new subdivision will be the present departments of Quality Control and Materials-Process Engineering. Newly organized will be the Manufacturing Reliability Assurance department which will work hand in hand with a new manufacturing reliability engineering group.

Conservation functions, formerly a part of Safety and Conservation, will also fall under the new setup, with safety being integrated into Industrial Relations.

"We feel that today's high performance aircraft and missiles require higher degrees of product quality and reliability than ever before in aviation history," Hynd said, "and we intend to meet these needs squarely."

Whittier, who also has been temporary Location Manager at the Douglas Palmdale Assembly and Flight Test facility, will be succeeded in that capacity by Harold W. Swartz, former Assistant Manager. Hal Bayer, Assistant Chief Service Engineer, will replace Whittier as Chief of the Service Engineering Department.

Providing the "Knockout Punch"
in Anti-Missile MISSILES

Missile Quality
FORGINGS
LABORATORY CONTROLLED

brochure gladly sent

THE BILLINGS & SPENCER CO.
HARTFORD 1, CONNECTICUT

New Automaton Beats Man's Speed 1,000 Times

An automatic information retrieval that is said to search out written information 1,000 times faster than a man could do it has been placed in operation at General Electric's Aircraft Gas Turbine Division in Cincinnati, Ohio.

The new system, believed to be the first of its kind, is based on the use of descriptive key words and on document file numbers. All technical documents in the AGT Library are carefully identified in terms of these key words. Each document may have a dozen or more words to describe it, and all documents pertaining to the same subject will be listed by number with these terms. In addition, a concise, descriptive abstract is prepared for each document in the system.

All this information is transferred to a series of magnetic tapes for use in the electronic computing equipment, located in the same building with the Library. At present there are more than 30,000 document abstracts recorded on just three tapes; there are over 7,000 key words describing these documents; and there are more than one-quarter million document file numbers coordinated with the words in the system.

The retrieval system, using IBM computing equipment, can search through the entire list of numbers in less than three minutes. And in less than 15 minutes, the time depending on the number of documents it found during the search, the system will deliver printed abstracts of those documents. Each abstract carries the requestor's name and address, the document's title, author, and file number, and the security classification of the material.

- **Too much data?** Before the system was put into use, an average literature search by trained personnel required as many as 14 hours.

Reid Barton and Lee Caplan, designers of the computer program, explain that in its present form the system can accommodate 1,000,000 abstracts, 56 million file numbers, and can perform up to 99 simultaneous literature searches. Barton adds: "New computing equipment is available which could increase the speed of our present system by 1,000%, while the document storage capacity would be around 10,000,000."

The need for additional speed and storage capacity may not be far in the future. Reliable estimates show that well over 2 million technical documents were published in the world last year. And statistics indicate that the rate of output will double every 10 years.

Speculating on the future, Mr. Dennis, manager of the AGT library says: "Our system performs even better than we had hoped. But it is only the first step in automatic literature searching. I visualize that within the next 10 to 20 years the nation's entire industrial community will be tied together through a network of sophisticated automatic retrieval systems. Published data from other industries, government agencies, and educational institutions will be made available to the inquiring engineer merely by feeding questions into electronic searching system at his place of work.

These questions will be channeled to all the technical data centers in the network. At each center an automatic retrieval system, probably based on ours, will search through all the documents available. They will then transmit the material back through a filtering center, which will eliminate all duplicated documents, and forward the information to the waiting engineer."

HUCK AIRCRAFT FASTENERS

HUCK CKL Fasteners have played an important part in the development of America's faster-than-sound airborne craft.

Their many unique features offer maximum dependable strength at minimum installed cost, plus:

- High strength to weight ratio.
- Positive mechanical lock.
- Excellent sheet pull-together.
- High shear and tensile strength.
- Absolute sealing quality.
- Simple visual inspection.

There is a HUCK fastener to meet your requirements. Our specialized fastener experience is at your service.

HUCK MANUFACTURING COMPANY
2480 Bellevue Avenue Detroit 7, Michigan

Circle No. 38 on Subscriber Service Card.

Constant Current Generator Has Wide Range

A new Model CC2000 Constant Current Generator is a transistorized, regulated, AC-operated design providing adjustable constant current over a wide range of output load variation.

This supply is intended for all types of constant current applications including transistor testing, transistor biasing, solenoid operation, instrument calibration, electro-plating, chemical testing, and other medium or high current applications.

Electronic Research Associates, Inc., asserts the Model CC2000 accomplishes current regulation by means of a transistorized series regulator whose resistivity is varied in proportion to the change of current in the output load.

The regulator includes a current reference source utilizing a silicon zener diode network and differential DC amplifiers are utilized in order to obtain optimum thermal stability.

A second source of voltage is connected in series with the constant current generator and this adjustable source provides a centering voltage setting for the unit.

Input power for both the voltage source as well as the current source is regulated by means of magnetic elements which compensate for slow variations in the input line voltage. In addition to absorbing the slow input variations, the magnetic regulator reduces the build up of voltage across the transistor regulator and hence promotes conservative operation.

The Model CC2000 provides an output current which is adjustable over the range 25 ma-2 amperes. Operating voltage point is adjustable over the range 0-180 VDC. Current ripple is less than 0.05% RMS. The unit is designed for bench or 19" relay rack mounting with a 10" panel height, and includes both voltage and current metering. Operation is for an input of 105-125 VAC, 60 cps.

Circle No. 299 on Subscriber Service Card.

Relay Test Sockets For Component Connection

The **Barnes Development Co.** Test Socket provides a method of connection to a wide variety of components with hermetic, seal headers of the hook, pin, or flattened terminal types used on relays and other components.

The socket is said to be durable to withstand production test usage, with mica filled epoxy or teflon dielectric, beryllium and copper contacts and mutually insulated dual contacts on each connection. This dual contact is claimed to have advantages in contact resistance evaluation of relays in that a current and measuring terminal is provided. There are advantages also in dry circuit testing where the dual contacts paralleled provide an extremely reliable, low-resistance contact to the relay.

Circle No. 298 on Subscriber Service Card.

Time Delay Relay Offers Instantaneous Recycling

A time delay relay, factory preset to give delay times from 50 milliseconds to 50 seconds, is said to offer instantaneous recycling. It is developed by **Masters Specialties Co.**

The unit has a transistor control circuit, with a relay contact as the only moving part. Weighing four ounces, this time delay relay is accurate from 18 to 32 VDC, and −55°C to +71°C.

The hermetically sealed unit uses printed circuit construction. It will

marion

advancement in instrument design

VERSATILE MULTI-RANGE METER TESTER

Model M-2

...POWER SUPPLY...LIMIT BRIDGE

Precise, self-contained unit for laboratory and production use. For DC instrument calibration from 25 ua full scale to 10 ma full scale, and 0-100 VDC; sensitivity and resistance measurement; DC current-voltage source; limit or bridge measurements from 0-5000 ohms. Regulated power supply. Stepless vacuum tube voltage control. Accuracy exceeds ¼% (current), ½ ohm or ½% (resistance). For 115V, 60 cycle AC. Complete — needs no accessories. Bulletin on request. Marion Electrical Instrument Co., Manchester, N. H., U. S. A.

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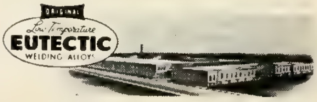

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3 vital functions

The ATLAS count-down ends—Sundstrand Turbo precision products go into action.

INSIDE THE MISSILE—the hot-gas accessory power unit, built by Sundstrand Turbo, provides hydraulic and electrical power.

ON THE GROUND—Sundstrand Turbo provides integrated ground support equipment, designed and built for both R&D and operational phases.

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Sundstrand Turbo experience in creating secondary power systems using bi-propellants, monopropellants, and solid propellants—combined with research in nuclear, solar, and atomic power systems—has made the name Sundstrand Turbo synonymous with Secondary Power. *Our engineering representative will be pleased to discuss your requirements.*

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17-7 PH
17-4 PH

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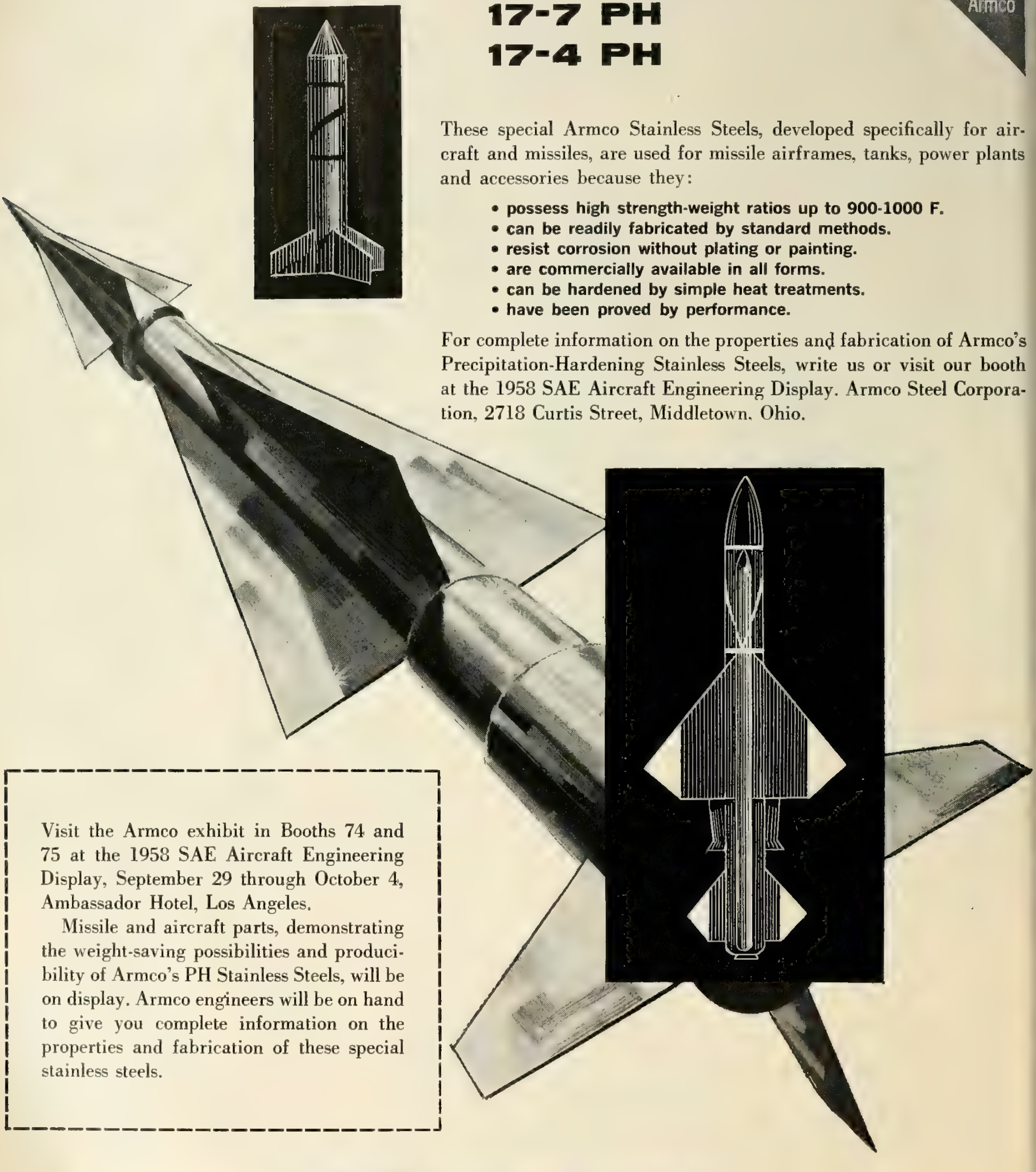

These special Armco Stainless Steels, developed specifically for aircraft and missiles, are used for missile airframes, tanks, power plants and accessories because they:

- **possess high strength-weight ratios up to 900-1000 F.**
- **can be readily fabricated by standard methods.**
- **resist corrosion without plating or painting.**
- **are commercially available in all forms.**
- **can be hardened by simple heat treatments.**
- **have been proved by performance.**

For complete information on the properties and fabrication of Armco's Precipitation-Hardening Stainless Steels, write us or visit our booth at the 1958 SAE Aircraft Engineering Display. Armco Steel Corporation, 2718 Curtis Street, Middletown, Ohio.

Visit the Armco exhibit in Booths 74 and 75 at the 1958 SAE Aircraft Engineering Display, September 29 through October 4, Ambassador Hotel, Los Angeles.

Missile and aircraft parts, demonstrating the weight-saving possibilities and producibility of Armco's PH Stainless Steels, will be on display. Armco engineers will be on hand to give you complete information on the properties and fabrication of these special stainless steels.

ARMCO STEEL

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the unique foundry methods of
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withstand exceptional shock and vibration. The relay can be delayed pull-in, or delayed drop-out. Contact rating is 5 amp. resistive.

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Long-Life Hose Made By Zero-Motion Braiding

A new wire braiding technique, which greatly increases hose life and decreases elongation and contraction under pressure to less than ½ of 1%, has been developed and put in production by **Titeflex, Inc.,** Springfield, Mass., a subsidiary of Atlas Corp.

A sudden application of pressure on a flexible hose creates axial and diametric forces within the hose. Since the innercore is elastic (400% elongation), all the forces are transmitted directly to the braid. The axial force will tend to elongate the braid; the lateral forces, meanwhile, tend to cause a diametrical expansion and thereby cause a contraction in length.

It was established that if the individual braid wires are applied at a certain angle, the tangent of which is equivalent to the ratio of the axial force to radial force, there will be no relative motion among the wires. This braid process angle is equated, the angle having a tangent equal to the pitch of the helix of the braid length, divided by the braid circumference.

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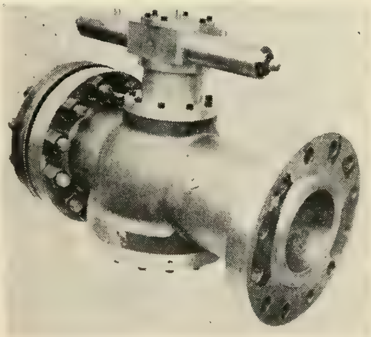
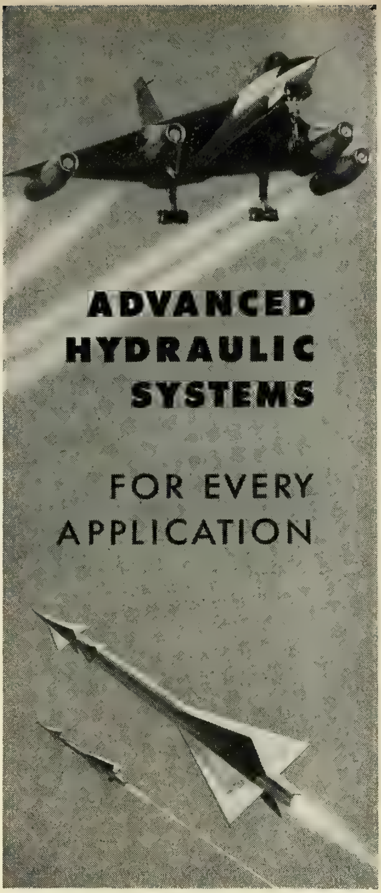
Pressure Ball Valve Largest Size Made



Hydromatics, Inc. has produced and delivered an initial quantity of 8″ ball-type control valves, intended for high pressure systems up to 2,000 psi and temperatures up to 225° F.

These valves mark the first time that a fast-acting, ball-type unit has been successfully designed and built for large size lines.

Controlled by pressure operated actuator, these valves are notable for



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MISSILE ENGINEERING

The "collapsing of time" concept has taken on added significance as a result of the current international situation. In Tucson, Arizona, Hughes has established the Tucson Engineering Laboratory for the purpose of shortening the elapsed time between missile development and its effective tactical use. This activity, established over 2 years ago, has proven that the quasi-simultaneous development and production of missiles can become a feasible reality.

The Tucson Engineering Laboratory is now expanding its scope of operations. Mechanical Engineers, Electrical Engineers, or Physicists who like to work on urgent problems and who have the ability and enthusiasm to constantly improve the product and its reliability, will find this an ideal environment. Specific areas of interest include: missile system analysis, infrared and radar guidance systems; electromechanical and hydraulic control systems, missile and test equipment and electronic circuit design.

An added advantage: Tucson's dry healthful climate. Investigate by sending resume to Mr. W. A. Barnes at:

the West's leader in advanced electronics

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TUCSON ENGINEERING
LABORATORIES
Hughes Aircraft Company
Tucson, Arizona

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their response characteristics . . . capable of two full travel cycles per second, or ten cycles per second through any 10% portion of a full stroke.

The overall valve envelope is considerably smaller than any unit previously available for full flow operation at pressures up to 2,000 psi.

Smooth, fast acting response is assured by bearing-mounted shafts. The valves may be used with a wide range of liquid or gaseous media, providing bubble-tight flow control.

Circle No. 295 on Subscriber Service Card.

"Viton" Wiring Fastener Designed for Missile Use

"Viton" synthetic rubber, **Du Pont's** new fluorine-based elastomer, has been adapted to a recently developed wiring fastener.

The fastener consists of a U-shaped nylon cradle and a flexible clip of "Viton" which cinches across the open end of the cradle and locks under inverted lips, holding a bundle of wires securely in place. Not only does this fastener provide a neater and more secure wire bundle than tape, string, or wire wrapping, says Du Pont, but it can be installed in about half the time.

The fastener was designed originally with a clip of neoprene synthetic rubber. But with temperatures as high as 300 degrees F., accompanied by the presence of lubricants, aromatic fuels, hydraulic fluids, and other strong oxidizing agents, "Viton" is required for the clop material. "Vitone" has the further advantage of being even more resistant than neoprene to ozone, sunlight, and weather.

Circle No. 294 on Subscriber Service Card.

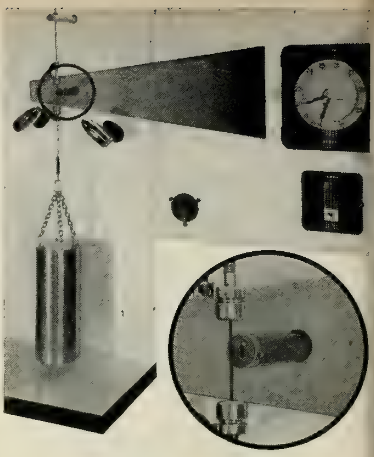
Miniature Switch For Timing-Control

A high-speed miniature stepping switch is now available from **IMTRA Corporation.** The "Miniature Uniselector" is designed, according to the manufacturer, for use in automatic switching and timing-control circuits.

The Uniselector will operate at speeds up to 80 steps per second on impulse drive (80% make, 20% break) from a power supply of 24, 50 or 110 volts d.c.

Up to twelve banks can be fitted, each having 30 individual contacts mounted in a complete circle. When seven or less banks are required, a sequence switch can be fitted. This takes the form of an auxiliary bank of contacts and wiper assembly. The sequence switch wiper steps once for each complete revolution of the main wiper assembly. All wipers can be either bridging or non-bridging.

Circle No. 293 on Subscriber Service Card.



KENTANIUM*
"flexes its muscles"
for inter-planetary flight

All of the development work in projected inter-planetary flight, and actual super-sonic flight, point up the importance of thermal shock resistance in the materials used.

On the test stand shown, Kentanium is demonstrating its claim to this all-important property. A Kentanium rod .156" in diameter, loaded to 8000 pounds per square inch, is heated to 2000°F., then cooled to 300°F., on a one-minute cycle. After 1000 continuous cycles, the specimen is still unbroken.

One of the many places where this thermal shock resistance of Kentanium may make a vital contribution is in impellers for gas turbines. Here any fuel failure immediately subjects the part to terrifically severe thermal shock, as the temperature falls. During experimental operation of one such unit, there were several emergency shut-downs due to fuel failure. No damage to the Kentanium impeller was incurred.

Many of the finest ideas of both science and industry have been "grounded" for want of materials with the necessary service properties. Many are getting off the ground now, as designers and engineers discover the unusual combination of characteristics available in the Kennametal* family of metals. If you have any applications where thermal shock resistance, resistance to corrosion, abrasion and erosion, or unusual strength and stiffness are important, ask for Booklet B-111A. Write KENNAMETAL INC., Dept. MR, Latrobe, Pa.

*Kentanium and Kennametal are the trademarks of a series of hard carbide alloys of tungsten, tungsten-titanium and tantalum.

3059

INDUSTRY AND
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...Partners in Progress

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space age

by Norman L. Baker

Engine future brightens—Now it's a 1.5-million lb. thrust rocket engine program that has received the DOD nod. An initial $2-million Army contract to Rocketdyne for an engine system to place "very large payloads into orbit" could well be the first major step toward putting a manned satellite into orbit. Clustered engines should be able to orbit a 30,000-lb. manned satellite or a 7-8000-lb. interplanetary vehicle.

Navaho **refuses to die**—For a missile system that was considered too uneconomical after absorbing an aggregate DOD funding of $690-million, the WS-104 *Navaho* continues to prove its worthiness in repeated tests at Cape Canaveral. Both *Navaho* and its booster demonstrate unlimited possibilities for future weapon systems and space vehicles. The *Hound Dog* air-to-surface missile is a direct descendant of the bird—*Dyna-Soar* may be another.

World peace through space travel—The abolishment of national claims to the moon and the planets of the solar system is expected to be a major issue on the provisional agenda of the United Nation's assembly. Secretary General Dag Hammarskjold, voicing the proposals of the United States and Russia, has called for international agreement which would rule that outer space should be a community affair with individual power claims to celestial bodies illegal.

Balloon satellites near launch—The density measurement expandable ballon satellites for the *Explorer* and *Vanguard* programs are undergoing operational tests at NACA's Wallops Island facility (see page 18). Twelve-ft. spheres (for a forthcoming *Explorer* shot) and 30-inch models (sub-satellite for SLV-4 *Vanguard* shot) have been sent aloft in high altitude flights and inflated successfully.

Black Knight **to be assigned space role**—The British IRBM, *Black Knight,* successfully tested two weeks ago (see m/r, Sept. 15, p. 7) and reported to technically advanced over the *Thor* and *Jupiter* will be adapted for satellite and lunar probe shots. The 2-2500-mile solid propellant missile, with the addition of two stages, is scheduled to start launching larger and more complicated satellites than the United States has launched to date.

Fixing coordinates in space—Space Navigation will be major topic at October 27-28 meeting of the 5th annual East Coast Conference on Aeronautical and Navigational Electronics sponsored by the IRE in Baltimore.

A new heat-converting material, said to be capable of converting heat directly into electricity, has been disclosed by Westinghouse Electric Corp. The material is a ceramic, which, according to company sources, can convert heat emanating from any source directly into electrical current, simply by passing the heat through the material. Use could be for power for satellites, radios, scanners.

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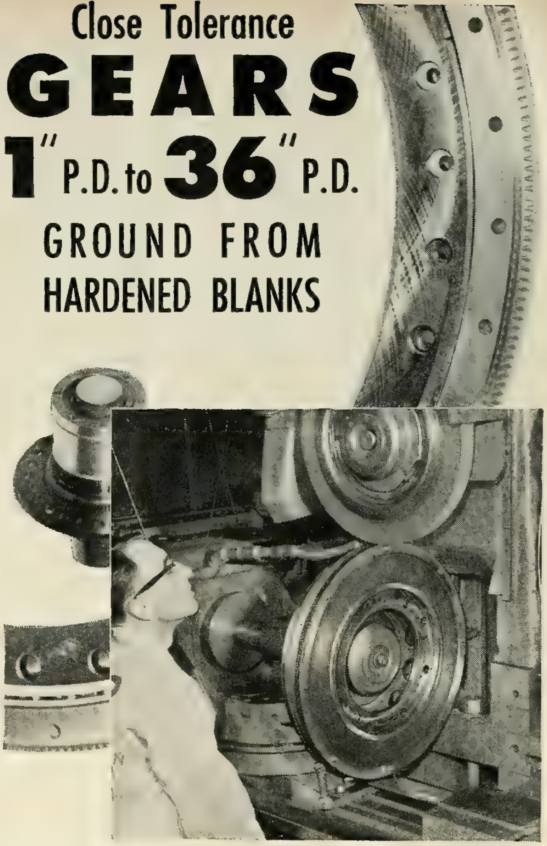
1" P.D. to 36" P.D.
GROUND FROM
HARDENED BLANKS

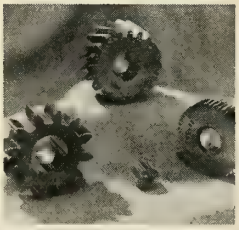


Gears ground on gear grinding machines designed, made and used only by Vinco, have an accuracy of tooth form, tooth space and a high quality of finish seldom equaled. These fine gears have been meeting the exacting requirements for jet engines, radar equipment, guided missiles and instruments for many years. This proven performance and experience is your assurance that Vinco ground gears will equal or better specified tolerances and fulfill performance requirements.

These highly accurate gears can be produced in pitches ranging from the coarsest to 240 and in quantities from one to multiple thousands.

Master Gears

Vinco master gears provide the most accurate means for checking the rolling action of production gears. Vinco produces extremely accurate master helical (spiral), spur gears and master worms.



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REWARDING RESEARCH OPPORTUNITIES for engineering specialists now exist in the Advanced Engineering Department of the TAPCO GROUP at Thompson Products. This is a continuing and expanding program. The TAPCO GROUP, made up of five major Thompson divisions, is serving the Aero-Space, Electronics, Nuclear and General Industrial fields with fully integrated facilities for research, development and production of structures, propulsion systems, electro-pneumatic-mechanical auxiliary and accessory power systems, electronic controls and check out equipment, and fuel systems involving solid-state, liquid and nuclear fuel studies.

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INFORMATION THEORY ANALYST—Experienced in mathematical analysis of mechanical and electromagnetic transmission of information.

PHYSICIST—Familiar with the physics of gases and liquids, mechanical and electromagnetic wave propagation within these media.

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MAGNETO HYDRODYNAMICIST—To work on advanced propulsion systems.

APPLIED MATHEMATICIAN—Experience in logical programming of systems and interest in communication and probability theory.

Your complete resume should contain personal, educational, experience data, and salary requirements. Send to DIRECTOR OF PLACEMENT. All replies will be held in strict confidence.

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letters

CED Query

To the Editor:

I was much interested to read in the September 1st issue of your excellent magazine that the Committee of Economic Development has published a pamphlet entitled, "The Problem of National Security—Some Economic and Administrative Aspects."

I wonder if you would be good enough to let me know where I might obtain a copy of this pamphlet.

C. C. Keefer
Director, Canadair Ltd.
P. O. Box 6087
Montreal, Canada

CED's address is 775 Fifth Avenue, New York, N.Y.—Ed.

Rights of Press

To the Editor:

I have several questions that I must, in all conscience, ask after reading the editorial opinion in the September 1 issue of m/r.

Is not the press, "public and business," a tremendous industry? Is not the press an industry of free enterprise—competing in kind with all members of the industry? Then, disregarding the trite old journalistic concepts of freedom of the press, why should the press have license to sell at $8.00 or so per year, our priceless scientific and technical information to those who would overpower our Nation?

The 'duty" to keep the general public informed on matters in which m/r has special competence is nice reading, but why not print the facts? If m/r and similar "trade journals" did not publish, in great and often erroneous detail, items regarding our missilery and related scientific failures and achievements, these journals would not sell many copies and after all, the sale of the published material is the important thing, not the actual contents, right?

Incidently, calling yourselves the nation's press, the "public" press is the subterfuge of the century. Is not the press private enterprise, trying to make a profit?

R. L. Reichard
Box 1279
Alamogordo, New Mexico

m/r is a profit-making institution and hopes to continue as such. The right to exist and compete among the free press is guaranteed by the Constitution, whose authors fervently felt that the public's right to know both pleasant and unpleasant news was one of the major rights of free men.—Ed.

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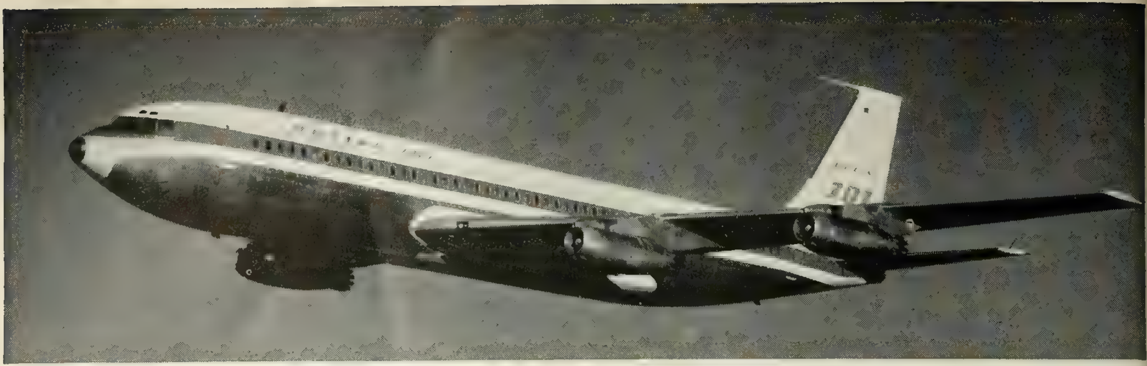
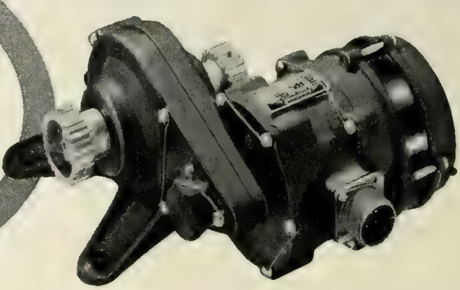


Emergency flap drive on Boeing 707 Stratoliner is provided by Airborne Model R1624-1 special-design rotary actuators. Units are permanently coupled to flap linkage, provide electro mechanical drive in event of hydraulic failure. Output shafts are driven whenever hydraulic system operates, but because of special inertial clutch, rotors do not turn unless energized.

AIRBORNE LARGE SPECIAL ACTUATOR SOLVES EMERGENCY FLAP DRIVE REQUIREMENTS ON BOEING 707



Specifications: Motor: 200/115 v a-c, 400 cycles, 3-phase, reversible. Speed at rated torque (450 in-lb): 85 rpm ± 10 rpm. Duty cycle 3 min. on, 27 min. off. Operating range: 102-124 v (line to neutral); 380-420 cps; −65 to +160°F; 0-50,000 ft. Weight 12 lbs.

In addition to offering an extensive line of modular-type electromechanical actuators, Airborne can also meet your requirements for large special designs—linear or rotary. Typical of these special Airborne actuators is Model R1624-1, used on Boeing's new 707 Stratoliner to operate the flaps in the event hydraulic power is lost. At the right are some of the more difficult engineering problems that were presented by this specialized application, along with Airborne's solutions to them.

PROBLEM	SOLUTION
Rotor to be disconnected from output gear stages except when motor is energized in either direction.	Inertial clutch—consisting of small weights in a cage—incorporated between motor and gear train. Makes positive contact with intermediate drive gear only when rotor shaft turns.
Starting torque to be 800 in-lb minimum, with pullout torque of 900 in-lb (±100 in-lb) at 50% motor slip (±10%) under all voltage, frequency and environmental conditions.	Special lightweight motor developed by Airborne to meet these exacting requirements. Rated .9 hp at 10,300 rpm, drawing 2.5 amp maximum.
In event of a jam in actuator transmission or rotor, unit to be fail-safe by permitting rotation of output shaft by torque of 1000-1300 in-lb. Once started, rotation to be maintained by torque not exceeding 100 in-lb.	Special ball-detent, torque-limiting clutch incorporated on output shaft.

Contact us for recommendations on your special actuator requirements . . . or for information on Airborne's standard line of modular design actuators.

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missile business

by Fred S. Hunter

New plant construction in Los Angeles by companies identified with the missile or electronic industries has not come to a complete halt. Witness the Ramo-Wooldridge Corp's plans to establish a new research and development complex on a 90-acre site in the Chatsworth area. But factory acreage within the boundaries of Los Angeles County is getting scarce. In order to make use of the Chatsworth location, Ramo-Wooldridge faces the necessity of obtaining a zoning clearance, and this is for a facility entailing no factory chimneys.

Choice factory sites, where no restrictions are imposed—except smog control—and where trackage is available, are being priced as high as $45,000 and $50,000 an acre. This is too high for most companies, and more and more companies are moving out to adjoining counties to meet their expansion needs.

The population of Orange County, adjoining on the south, is up over 150% since 1950, making it the fastest growing area in southern California. Here, in Fullerton, Hughes Aircraft Co. has located its ground radar equipment division and has a new 300,000-square foot plant under construction. The plant site is 42 acres. In the acquisition of so much acreage, Hughes is, of course, allowing for future plant expansion.

But the big reason for a 42-acre site for a plant occupying about 7½ acres is the employe parking problem. The first question the personnel manager of a company will ask about a proposed new factory site is: "How much space for parking?" Workers in southern California think nothing of driving 15 or 20 miles to and from a job, but if convenient parking isn't available practically at the factory door, they're off to another company.

Aeronutronics Systems, Inc., the Ford Motor Co.'s missile and space subsidiary, is another new Orange County resident. It is building its new facility in the Newport Beach area, where living conditions should appeal to engineers and scientists and where space for parking is available.

Other examples of southern California companies displacing the orange groves and bean fields in Orange County include: Hallamore Electronics, B-J Electronics, Interstate Electronics, Foster Manufacturing, Narmco, Cherry Rivet, Nutt-Shel, Cooper Precision and Northrop's Anaheim Div.

Charles B. Thornton, president of Litton Industries, predicts that electronic firms will eventually replace the aircraft industry as the Los Angeles metropolitan area' No. 1 employer. Thornton points out that the square footage of electronics plant facilities has increased from 10 million in 1955 to 26 million this year. A share of this increase took place in Orange County, whose northern sections are counted as being part of the Los Angeles metropolitan area.

At the opening of its giant factory in San Jose, International Business Machines disclosed it has orders for 1000 RAMAC data-processing machines. At rentals ranging between $3,100 and $4,500 per month, this means a gross rental of about $4 million a month for IBM.

Company Notes: Datafax Instruments—a new program of Convair Division of **General Dynamics Corp.**—has been organized to design, develop and produce specialized electrical instruments and instrument systems at La Jolla, Calif. . . . **AMF** has completed studies of transporting, handling and launching *Atlas* . . . **Air Reduction Sales Co.** is building a new plant at Denver.

contract awards

LAST MINUTE ITEMS

A. C. Spark Plug Division of General Motors Corp. gave Electro Instruments, Inc., San Diego, $1.4 million for digital test equipment to be used in the *Thor* ICBM program.

AF awarded **Aerojet-General Corp.** $1,106,470 for large solid rocket production and solid propellent production facilities.

Olympic Radio and Television Division, Siegler Corp., was awarded $350,000 for research and development to design the AN/TPQ-11, a ground-based radar operating in a 35,000 megacycle range.

International Business Machines Corp. received a contract totaling $2,631,122 for automatic data processing equipment.

Republic Aviation Corp. was awarded $1,318,825 for short range surveillance drone engines.

ARMY

By Signal Supply Agency:

Radiation, Inc., Melbourne, Fla. received $119,680 for multi-helical antenna system radiation.

By Quartermaster Research and Engineering Command:

Magnesium Products of Milwaukee, Wis., received $130,276 for seventeen shelters, frame type, warhead and thrust unit, mating *Jupiter* system.

Radio Corp. of America, Cherry Hill, Camden, N.J., received $103,188 for services of qualified technicians in connection with courses of instruction for training groups of military and other personnel, and providing specialized technical assistance to the U.S.Army Ordnance Guided Missile School.

The Deutch Co., Los Angeles, Calif., received $39,723 for miniature electrical connectors.

AIR FORCE

By Cdr. HQ AMC, Wright-Patterson AFB:

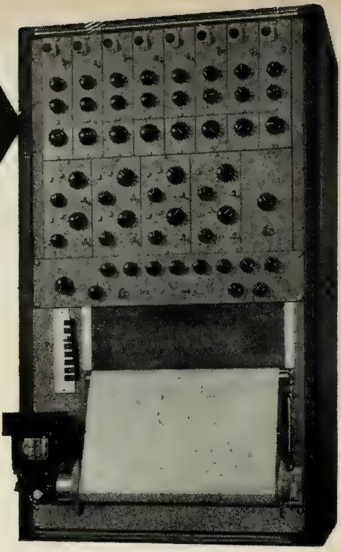
National Northern Corp., West Hanover, Mass., received $36,272 for producing forgings through the use of explosives.

By HQ, Mobile Air Materiel Area:

AiRepair, Inc., North Hollywood, Calif., received $277,271 for oxygen regulators.

D. K. Mfg. Co., Chicago, Ill., received $38,415 for cylinder, oxygen low pressure type.

THE OFFNER ALL TRANSISTOR TYPE R DYNOGRAPH



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OCTOBER

National Symposium, sponsored by Institute of Radio Engineers and George Washington University, Extended Range and Space Transmission, Lisner Auditorium, Washington, D.C., Oct. 6-7.

Third Symposium on Hypervelocity, Host: Armour Research Foundation, Sherman Hotel, Chicago, Ill., Oct. 7-9.

Armour Research Foundation and Illinois Institute of Technology, Annual Noise Abatement Symposium, Hotel Sherman, Chicago, Ill., Oct. 9-10.

Fuels-AIME Conference, American Society of Mechanical Engineers, Old Point Comfort, Va., Oct. 9-10.

14th Annual National Electronics Conference, Hotel Sherman, Chicago, Ill., Oct. 13-15.

ASME, Lubrication-ASLE Conference, Statler Hotel, Los Angeles, Calif., Oct. 14-16.

Association of the United States Army, 1958 annual meeting, Sheraton-Park Hotel, Washington, D.C., Oct. 20-22.

Fourth Annual Symposium on Aviation Medicine, Miramar Hotel, Santa Monica, Calif., Oct. 22-24.

SAMA Laboratory Apparatus and Optical Sections' Midyear Meeting, Westchester Country Club, Rye, N.Y., Oct. 26-28.

Institute of Radio Engineers East Coast Conference, Aeronautical and Navigational Electronics, Lord Baltimore Hotel, Baltimore, Md., Oct. 27-28.

1958 National Metal Exposition and Congress, American Society for Metals, Public Auditorium, Cleveland, Ohio, Oct. 27-31.

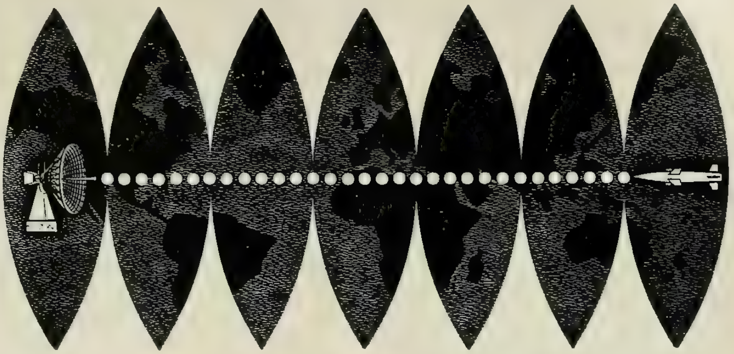
IRE, 1958 Electronic Devices Meeting, Shoreham Hotel, Washington, D.C., Oct. 30-31.

NOVEMBER

Fifth Annual Meeting, Institute of Radio Engineers Professional Group on Nuclear Science, Villa Hotel, San Mateo, Calif., Nov. 6-7.

Conference on Scientific Information, AFOSR/Directorate of Research Communication, NAS, NSF and the American Documentation Institute, Mayflower Hotel, Washington, D.C., Nov. 16-21.

American Rocket Society, 13th Annual Meeting and Astronautical Exposition, Hotel Statler, New York, N.Y., Nov. 17-21.



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book reviews

Three reports of human engineering research for the Armed Forces, including an extensive bibliography of the literature in the field, have been released for the use of industry and psychology researchers through the Office of Technical Services, U.S. Department of Commerce. The volumes are:

HUMAN ENGINEERING BIBLIOGRAPHY, 1955-1956. E. V. Saul, Tufts University for Office of Naval Research. Oct. 1957. (Order PB 131507 for OTS, U.S. Department of Commerce, Washington 25, D.C., $4.75.)

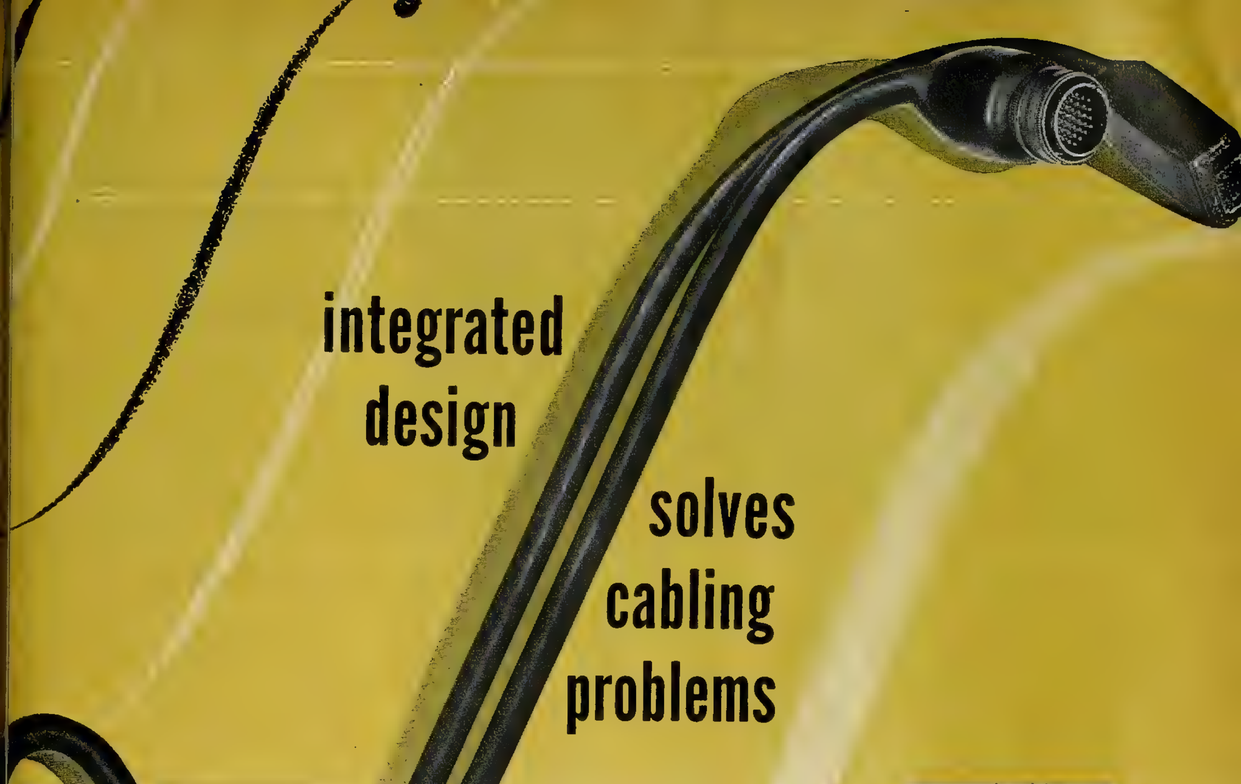
One of a planned series of bibliographies of literature concerning human engineering. Parts are devoted to a topical outline of literature, dummy of subject matter files, alphabetical index to the literature, abbreviations of military and government organizations, and a collection of more than 1,000 citations and abstracts. An author index is included.

HUMAN FACTORS CONSIDERATIONS IN THE DESIGN PROPOSALS FOR A BALLISTIC MISSILE UNIT PROFICIENCY SYSTEM. F. F. Kopstein and R. L. Morgan, Wright Air Development Center, U.S. Air Force. Dec. 1957. 17 pages. (Order PB 131696 from OTS, U.S. Department of Commerce, Washington 25, D.C., 50 cents.)

Provides an outline of steps in the design of a "Unit Proficiency System" for a ballistic missile program. The system is described as the means by which proficiency training and proficiency measurement are obtained in ballistic missile systems.

PSYCHOLOGICAL STRESS AS A THEORETICAL CONCEPT. W. D. Chiles, Wright Air Development Center, U.S. Air Force. July 1957. 20 pages. (Order PB 131616 form OTS, U.S. Department of Commerce, Washington 25, D.C. 75 cents.)

Some typical treatments of psychological stress are examined. The approach of construing stress in analogy to physical and psysiological concepts is rejected. According to the author, such approaches have not led to quantifiable insights into the action of stress with respect to human behavior. A systematic approach is suggested, along with the frame work for the quantification of psychological stress as a theoretical concept. Some implications of this approach with respect to performance variables are discussed.



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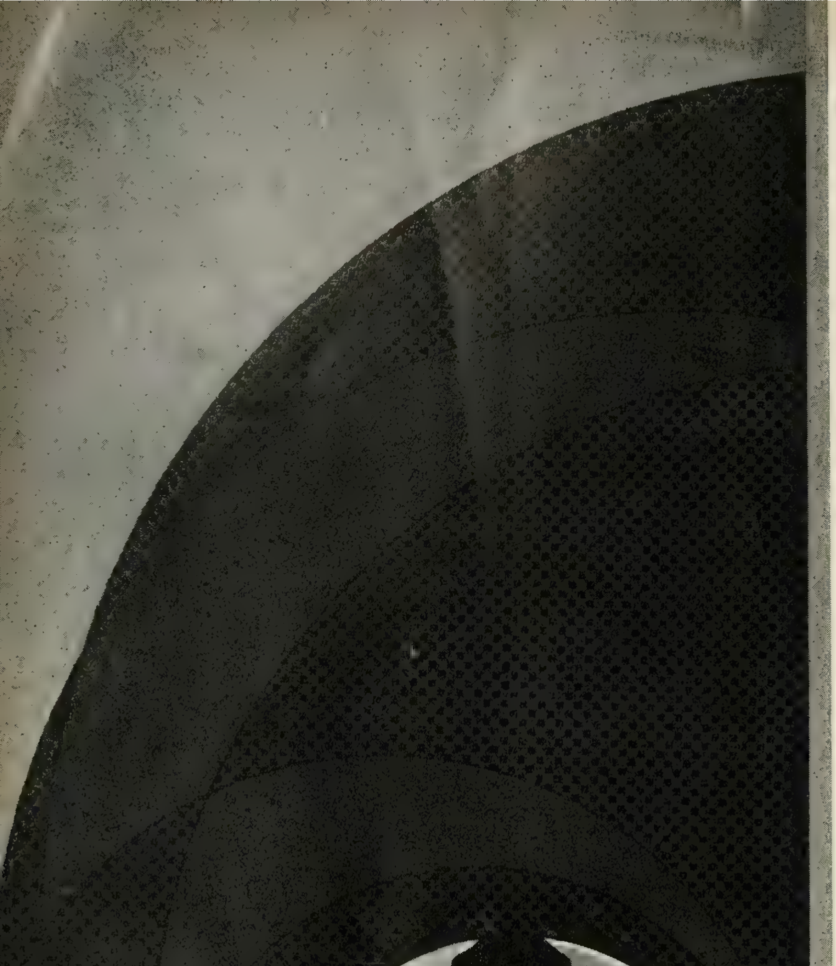

ACOUSTIC NOISE

When huge rocket engines lift a ballistic missile or satellite vehicle into the air, the thundering noise of the engines violently shakes intricate electronic components and the missile structure itself. Acoustic noise is one of the many environments that mu be thoroughly explored and understood by the missile designer.

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Engineers at Avco's Research and Advanced Development Division have this problem by designing a versatile high-intensity acoustic noise generator. Based on electromagnetic principles, it creates noise environments of the same frequency spectra as rocket or jet engines.

This successful effort is now part of the division's complete environmental testing laboratory, where it is producing information for Avco scientists and engineers responsible for ICBM nose co

Acoustic noise work is one of the many development programs that proceed simultaneously with theoretical and applied research at RAD. The mutual stimulation of scientists and engineers in many disciplines occurs naturally at Avco, where the search for new knowledge and its application go forward under one roof.

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soviet affairs

by Dr. Albert Parry

In their proud descriptions of the rocket experiment of August 27 which sent two dogs up to 279 miles above the earth and brought them back alive, the Soviets revealed an interesting point: They *do* drug their dogs for some of those rocket trips.

The August 27 rocket shoot was with undrugged dogs, Moscow says, and thus extremely valuable because it showed animals enduring "cosmic trips" in their normal state. But some Soviet rocket-flying dogs are drugged, Moscow mentions casually.

Only a short time ago Soviet propagandists loudly claimed that all their dogs were rocketed undrugged; but that American experiments with monkeys and mice being sent up in rockets or balloons were of no worth because Americans "always" drugged their animals. Yet now the Soviets reveal that they, too, drug their cosmos-riding dogs.

In commenting on the Red dog-flights, Professor Vladimir N. Chernigovsky, director of the Institute of Physiology of the Soviet Academy of Sciences, declares that the importance of their experiments is "inestimable" because they "give us grounds to believe that man will penetrate into outer space in the near future." He elaborates: "What we now know of the changes in the basic physiological functions of the test animal allows us, with certain amendments, to picture the physiological changes that will take place in humans under similar conditions."

Dr. Chernigovsky admits that the problem of sending man into outer space is far more complicated than the task of testing dogs on such journeys. Yet, he says, there are certain advantages, too.

One such advantage is that "men will not be *passive* passengers in their pressurized cabin" as dogs are. "Evidently there will be no need for a number of complex automatic instruments because the men in the ship will be able to meet their needs by operating the instruments themselves."

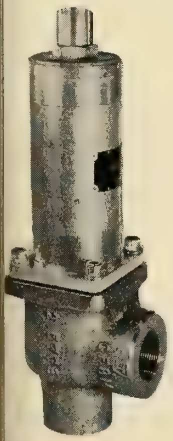
Not just astrophysicists and engineers, but medical men and psychologists are now working in the Soviet Union on the problems of the future space-flyers. In SOVETSKAYA AVIATSIA, Professor K. Platonov, a doctor of medicine, includes among the problems to be solved "the influence of such various factors of the cosmic flight on the spaceman's psyche as accelerations, weightlessness, isolation, and the like."

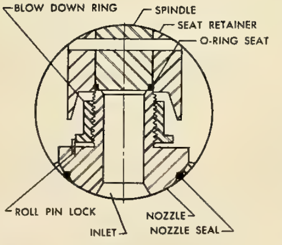
Oral communication by radio between the space-ship's crew and the Earth (says Dr. Platonov), should be preserved by all means as a tremendous positive effect upon the crew's morale. Weightlessness, psychologically and physically hard on the crew, can be combatted by such mechanical devices as special magnetized shoes, also by creating an artificial weight via the ship's orbiting around its own axis. The crew's feeling of monotony and isolation can be minimized by "alternating, inside the space ship, colors and sounds," also by lighting the cabin so as to create an imitation of day following night.

Sputnik Monument To Be Erected in Moscow

A Soviet team of two architects and one sculptor have been announced in Moscow as the winners of the first prize in the contest for the best project of a monument to be erected in the Lenin Hills near the University of Moscow, in honor of *Sputnik* I. Nearly 1,000 entries from 114 Soviet cities and many foreign countries had been submitted in the competition.

The monument, to be built of aluminum and to be covered with semi-transparent smoky glass, will consist of a 50-meter-high obelisk representing *Sputnik* I at the moment of its break-through into outer space.





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Airborne Accessories Corp. . . 54
AiResearch Mfg. Co., Div.-The Garrett Corp. 28
Allegheny Ludlum Steel Corp. 34
Anderson-Greenwood & Co. 61
Armco Steel Corp. 48
Avco Mfg. Corp., Research & Advanced Development Div. 60
Morris Bean & Co. 49
Bendix Aviation Corp.
  Bendix-Pacific Div., Bendix Aviation Corp. 49
  Scintilla Div. 56
Billings & Spencer Co., The . . 44
Blocksom & Co. 21
Boeing Airplane Co. 31
Breeze Corp. 19
Bridgeport Brass Co., Hunter Douglas Aluminum Div. . . . 17
Brunswick-Balke-Collender Co., The 12
Bulow Electric Co. 18
Computer Engineering Associates, Inc. 18
Consolidated Electrodynamics Corp. 23
CONVAIR, A Div. of General Dynamics Corp. 32
Cutler-Hammer, Inc. 27
Eastern Industries, Inc. 63
Electrical Engineering & Mfg. Corp. 10
Eutectic Welding Alloys Corp. 46
Flexonics Corp. 24
General Electric Co. 8, 26
Goodyear Tire & Rubber Co., Aviation Products 3
Huck Manufacturing Co. . . . 45
Hughes Aircraft Co. 50
International Telephone & Telegraph Corp. 7
Kennametal, Inc. 50
Ling Electronics, Inc. 64
Marion Electrical Instrument Co. 46
North American Aviation, Inc. 43
Offner Electronics, Inc. 56
Pacific Automation Products, Inc. 59
Pesco Products Div., Borge Warner Corp. 35
Propellex Chemical Corp. 58
Radio Corp. of America 57
Raybestos-Manhattan, Inc. . . 30
Raytheon Manufacturing Co. 40
Republic Steel Corp. . . . 37, 39, 41
Resistoflex Corp. 4
Robertshaw-Fulton Controls Co. 42
Rockwell Standard Corp., Transmission & Axle Div. . . 53
Servomechanisms, Inc. 2
Stromberg-Carlson Co., Div. General Dynamics Corp. . . 20
Sundstrand Turbo, a Div. of Sundstrand Machine Tool Co. 47
Telecomputing Corp. 6, 36
Teleflex, Inc. 35
Thompson Products, Inc. 52
Vinco Corp. 51
Westinghouse Electric Corp., Electronics Div. 38
White Aircraft Corp. 58
EMPLOYMENT SECTION
Chrysler Corp., Missile Div. 62

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CK VALVE. A newly-designed split-er check valve, adaptable to han-flow of all types of gases and ds in missile ground support or in-ial equipment, has been produced he Garrett Corp.'s AiResearch In-ial Division. Though the use of d materials, it can be made ap-ble to operational temperatures cryogenic levels to 1,000°F.

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ATION SYSTEM. Protects delicate such as missile controls, subjected rge and rapid "g" load changes. isolation system accomplishes this aintaining its desired low natural ency while limiting relative dis-ment at various load conditions. ystem, developed by Walter Kidde Co., Inc., consists of three inde-ent sets of servo-controlled gas gs, each set absorbing a compo-of the vibrational and acceleration ngs along one of three mutual per-icular axes.

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VITY LOCATING DEVICE. A new ine, versatile enough to find the t and center of gravity location wide range of rocket engine sizes, been developed by the Hunter-l Div. of Thiokol Chemical Corp. rate and simple to operate, this ine can also be used for weight C.G. locations of devices other rocket engines.

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GATE VALVE. Valves for handling liquid oxygen and other cyrogenics are now available from Koehler Aircraft Products Co. The valves can be used as pre-valves or fill valves under operating conditions involving line pressures up to 60 psi, and ambient temperatures ranging from −320 deg. F to +250 deg. F. The valves can be actuated manually, electrically or by pneumatic pressures.

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WAVEGUIDE WATERLOAD. A broad band power absorbing waveguide waterload-BL-570, developed by Bomac Laboratories, is said to be capable of absorbing up to 400 watts of C.W. power over the frequency range of 4.95 Kmc, and the VSWR is under 1.20 over this range. This represents a reflected power of under 1%.

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OSCILLATOR-MIXER. A new reference oscillator-mixer, model GRO-2, is said to combine four functions: generates reference frequency for addition to an FM/FM telemetering multiplex; mixes the reference frequency and the multiplex; de-emphasizes the multiplex spectrum for recording; matches reference and signal amplitudes. The unit is designed for use in tape speed compensation systems, and was developed by Data-Control Systems, Inc.

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CERAMIC TOOLING. Low-cost ceramic tooling suitable for operation up to 3,000 deg. F is now being produced by a casting technique using Sur-Braze Grade S-2 ceramic, a high-temperature material developed by Duramic Products, Inc.

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CAPACITOR MOTOR. Western Gear Corp., Electro Products division, is offering a 115V, 400 cycle, single phase capacitor start and run motor with a planetary gear reduction at each end. Dimensions are 5" long, 2½" in diameter.

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26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75
76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125
126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150
151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175

• • Missile Literature

200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224

• • New Missile Products

225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249
250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274
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NUCLEAR FUEL ELEMENTS. A new bibliography on nuclear fuel elements, believed to be the first such reference listing of available data on solid fuel elements, has been made available by Sylvania-Corning Nuclear Corp. The edition is titled "Bibliography on Solid Fuel Elements." The 64-page volume contains 306 references on problems concerning solid fuel elements, such as fabrication and properties. The references are arranged alphabetically, and include short abstracts of each item.

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FLUID POWER. Engineering data for designers who use fluid power motors, pumps, valves and cylinders, has been published in a 4-page bulletin by Commercial Shearing & Stamping Co. Bulletin 100-P3 is entitled "Designers' Check List of Commercial Fluid Power Components." The bulletin pictures each type of component, describes features, and includes tables of design and application data.

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PRESSURE TESTING. A new illustrated 16-page catalog and manual describing equipment and methods for sealing openings for pressure testing has recently been published by Mechanical Products Corp. The "Quick-Seal" line of test plugs and filling connectors is described by the new #658 manual, which illustrates the application of "Quick-Seal" units to many different types of openings.

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COMPUTER CONTROL. A new brochure is available on digital computer control and data logging from the Thompson-Ramo-Wooldridge Products Co. Included in the reference bulletin is a description of the RW-300 Digital Control Computer as well as comprehensive discussions of process control, data logging, pilot plant, and test facility applications for computer control systems.

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TOROIDAL CORES. A 12-page handbook for designers on the use of Genalex toroidal cores is available from Wallace E. Connolly & Co. The handbook covers permeability, temp ture coefficient of inductance, dc bility, core size and finish. Comp graphs and technical data on the characteristics of Genalex cores presented. The handbook charts phy and electrical properties of Genale cores.

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EOTS EQUIPMENT. The Electronic tical Tracking is considered the accurate cine-theodolite system in today. The system is fully describe an illustrated 12-page brochure off by J. W. Fecker, Inc., a subsidiary American Optical Co. Photogra diagrams and tables in the broc fully describe the components of EOTS system, as well as the theodolites themselves.

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SWITCHES. Micro Switch, a divisio Minneapolis-Honeywell Regulator has just published an enlarged 32-p edition of its Basic Switch Cata Significant innovations in basic swit for industrial and commercial app tions have been added to make catalog useful to the user of b switches. New mounting brackets auxiliary actuators for Micro Sw basic switches have also been adde

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LAMINATES. A 21-page technical manual containing test values curves, plus specification data on reliability epoxy glass copper clad unclad laminates for printed and o circuitry has been issued by the Corp. Such factors as requisite b strengths, flexural strengths, diele breakdown and constants are also cluded.

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POWDER. A new 4-page folder, troducing the New Oxweld A powder Lance," describes a revolut ary new tool capable of slicing thr concrete or metal of any thickness. curate control of intense heat is key to operation of the new lance veloped by Linde Co., Division of U Carbide Corp. No known materi not even new, super heat-resistant terials developed for high speed s travel—can withstand the piercing tion of the new ACL-3 Powder La The booklet outlines the origin, ciple, and scope of the powder-lan process. It also describes cost-sa applications in steel mills, foundries on construction and demolition jobs

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76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125
126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150
151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175

● ● **Missile Literature**

200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224

● ● **New Missile Products**

225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249
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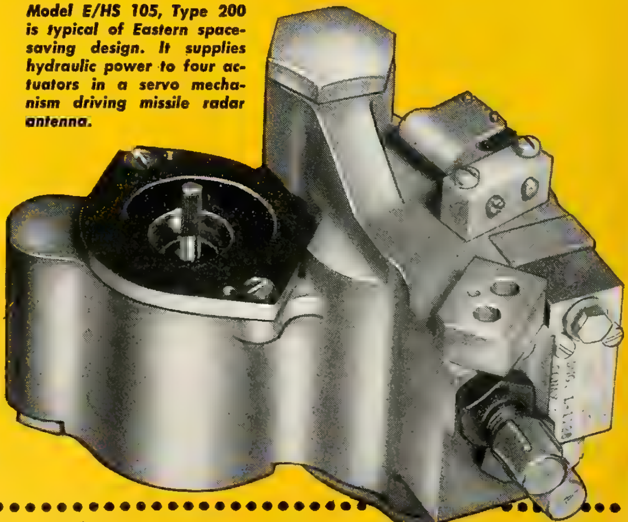

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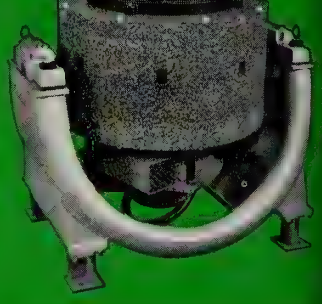

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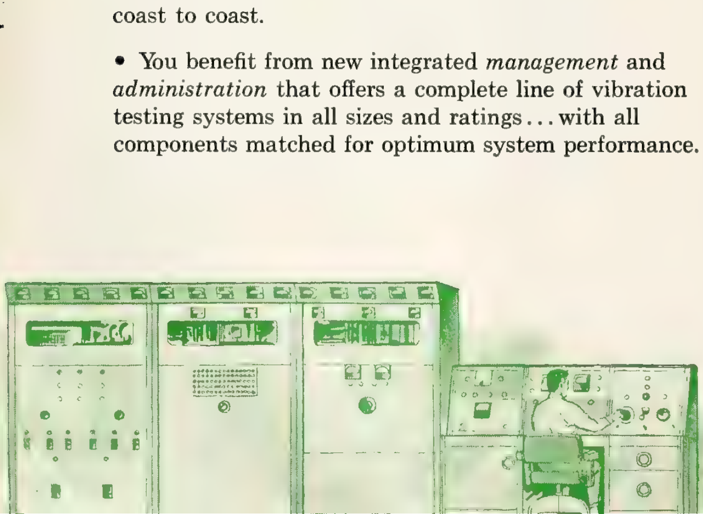

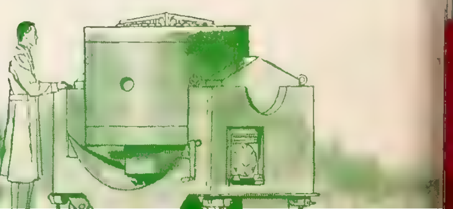

SEPTEMBER 29, 1958

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

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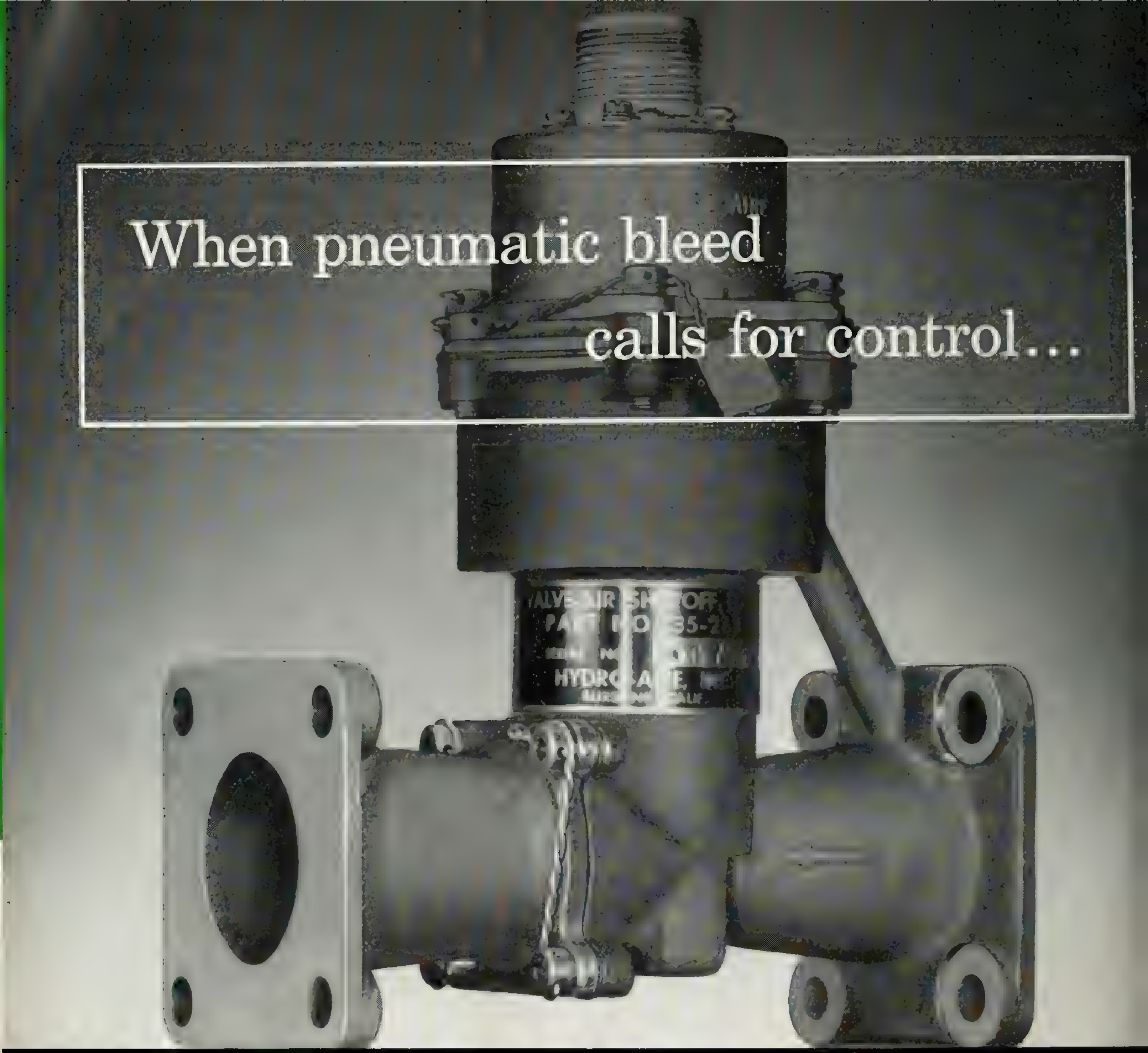
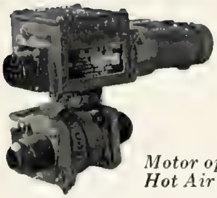
AN AMERICAN AVIATION PUBLICATION





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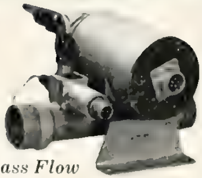

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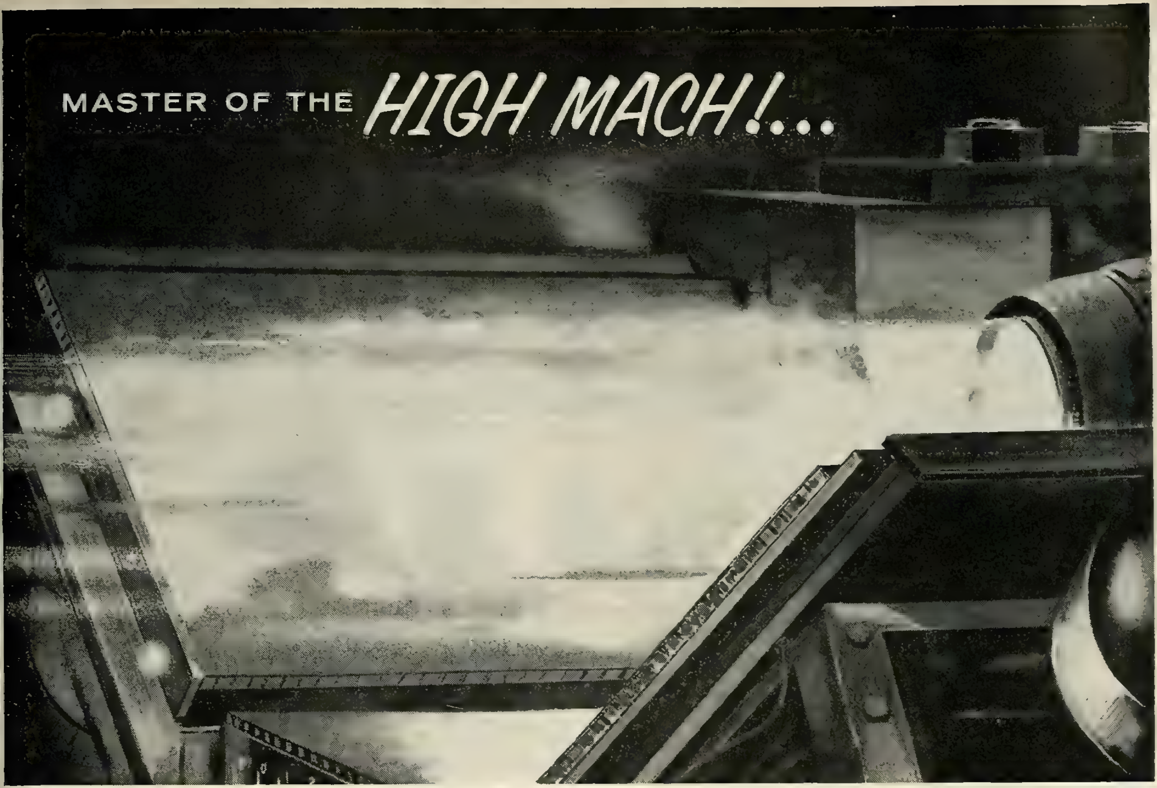

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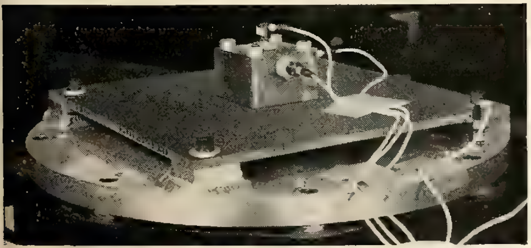

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SEPTEMBER 29, 1958
VOL. 4, NO. 13

missiles and rockets

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First Year Of The Space Age

During the latter part of September and the first days of October, 1957, a busy Russian rocket-science team—and it must have been a good and an experienced one—was working hard to get a sophisticated missile off the ground. The team must have been told about the great propaganda value of the experiment. Among others, rocket and space industry leaders from all over the world were meeting in Washington and Barcelona in those days. Thus, the world's press already was somewhat geared to space flight.

On October 4 the giant CH-10 converted Red ICBM satellite carrier roared aloft and successfully put into orbit the first man-made moon. One of man's biggest—if not the biggest—rocket industry breakthroughs was a fact.

The Red propaganda machine had won a major victory. Americans had been painfully scooped—in the eyes of the rest of the world—and in their own eyes.

To men of the American missile industry it is indeed clear that the first *Sputnik* meant considerably more than a Red propaganda stunt. Yet, to most people it meant that Russia was stronger than America, scientifically as well as militarily.

The true and significant meaning of *Sputnik* I, however, lies in the fact that the world is being rushed into the space age under the leadership of someone other than the United States—the country which customarily set the pace for man's advancement in important technological and industrial areas—in a democratic way. Nobody questions our superiority in industries such as transportation—rail, air or automotive, or in construction, or chemistry, or medicine and others. But in astronautics we are only second best.

In Russia, every child is being taught about the greatness of Professor Tsiolkovski, the "father" of space flight, according to the Russians. How many text books in this country mention Dr. Robert H. Goddard, the father of modern rocketry? Could it be we are still not accepting the fact that we are entering the space age?

It is easy to blame our derelictions on our political leaders and defense planners. But could it be that the man in the street—in his reluctance to recognize what others are achieving—should blame himself for not having employed enough foresight? If so, it is about time—now that the space age is one year old—that he make an honest attempt to revise his opinion about where mankind is headed, and how important it is that this country accept its missile industry's drive to get there first—and best.

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contents

Plasma Jet Development May Herald Breakthrough ... 11
Chemists Look To Missile Money ... 12
Automotive Engineers To Get Missile Briefing ... 12
Defective Valve Stymied *Vanguard* Attempt *by Norman L. Baker* ... 13
Titan Ready For Ultimate Test 14
FBM Navigation System Being Evaluated *by William O. Miller* ... 18
Adm. Clark: Boss of U.S. Space Projects *by Erica Cromley* ... 20
IRE Symposium on Telemetering *by Peer Fossen* ... 23
ISA Fears Technician Shortage 25
Electric Servos Aid Solid Fuel Shortage *by Raymond M. Nolan* .. 26
British Develop Glass-Fiber Launchers ... 29

DEPARTMENTS

Washington Countdown ... 7
Industry Countdown ... 9
Missile Business ... 16
Contract Awards ... 16
Missile Electronics ... 23
Propulsion Engineering ... 33
Missile People ... 34

"THE COVER"

The big stainless steel tanks of Air Force's Atlas ICBM are framed by a tooling ring at the San Diego plant of Convair's Astronautics Division. Big missile last week ran into trouble in its first full-scale test (see p. 29).

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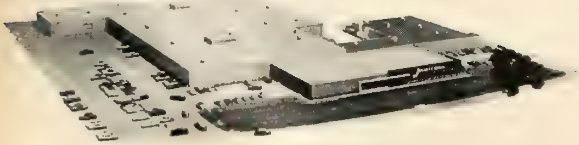

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washington countdown

First firing of the *Titan* . . .
will not be until October, probably during the second week. The missile in the gantry now is for testing ground service equipment, and is not a launchable bird.

Many detailed changes . . .
on the first-stage *Thor* are being made to ready the missile for the next lunar probe. The changes haven't been easy or simple. AF is seeking perfection, and if the shot goes on Oct. 11-14, it probably will succeed. Trouble last time was in propulsion.

The AF WS-117L . . .
is on schedule, but the international political implications pose almost as great a problem as the creation of this Lockheed recon-satellite vehicle. To avoid Russian protests, a launching under an extended IGY program would be simplest.

***Minute Man's* progress . . .**
has been almost astonishing, but disregard any reports it will overtake and supplant *Atlas* and *Titan*. Differences in payload (*Minute Man* is smaller) gives entirely different target potentials.

First supersonic target . . .
for any U.S. missile was the real test of the *Bomarc* shot at Cape Canaveral last week. The target was, of course, one of the *Navaho* boosters left over when that program was abandoned.

The fact that military reorganization
. . . did not really touch the most important area is a widespread feeling in the Pentagon. Centralization of research and development is considered paramount and most important—including authority to control contracts.

R&D director . . .
for the Department of Defense is still an unfilled job. Secretary McElroy recently said the post would be filled soon. A major problem is finding a man with the required background in military research and engineering, yet with the objectivity which frequently is impaired in acquiring this background. Any man smart enough to handle this tough job, someone remarked, should be too smart to take it.

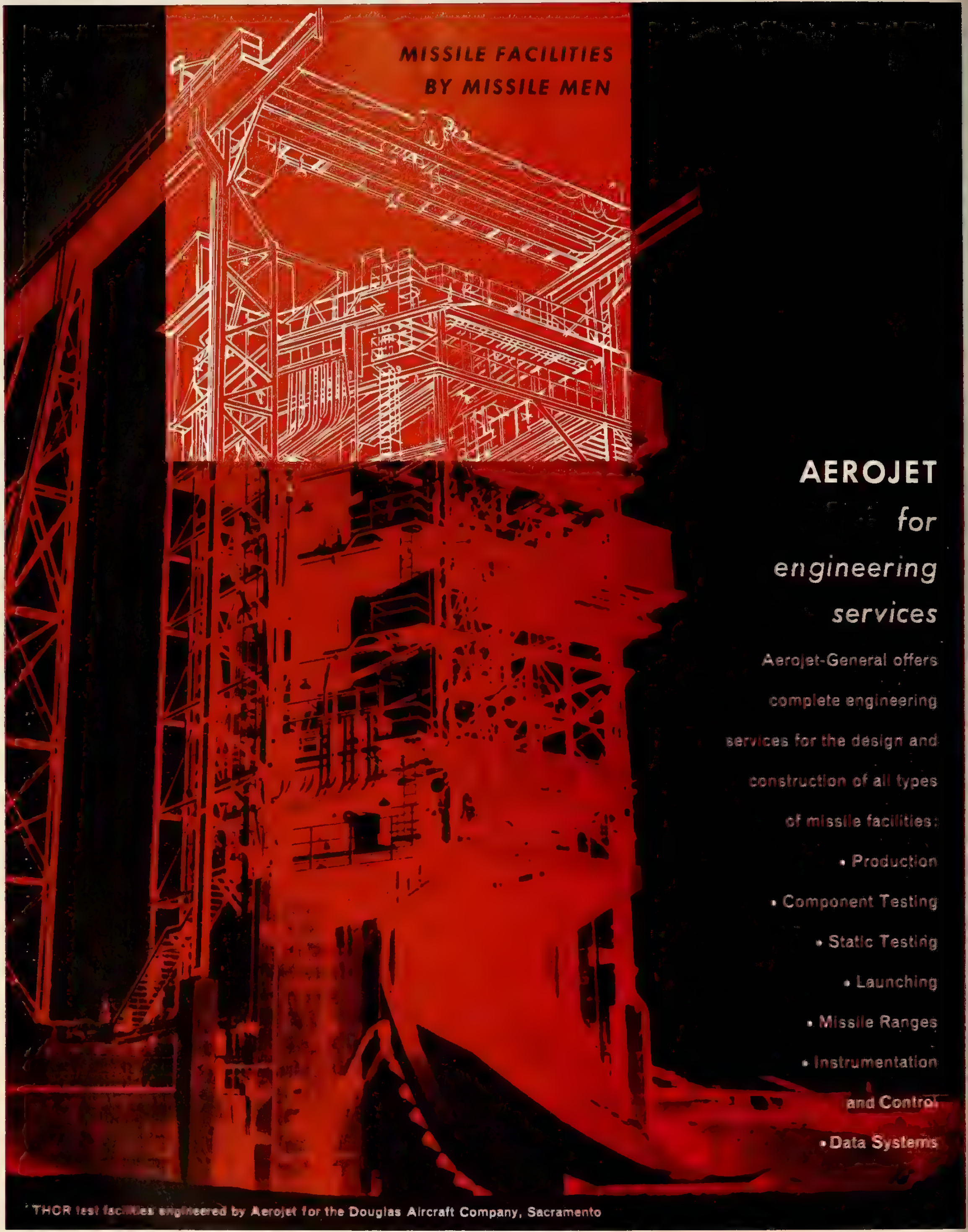
NASA's real test . . .
will come in the 1960 budget allocation, depending upon how Congress looks on the organization. The overall space program will receive a thorough investigation, which means the organizations concerned. Real support hinges on one thing: will this nation, through Congress, support an expensive space program divorced from the military appropriation with its inherent fear/defense motivation?

The nuclear-powered bomber . . .
is a subject of controversy within the AF. Big problem is utilization. One group says the bomber would have to fly too low and too slow. The other school of thought says it doesn't care how low or slow, so long as an air-to-ground IRBM can be hung on a plane which is able to remain on airborne patrol indefinitely.

Money is no major problem . . .
in the overall missile development program, that is, on genuine missiles. Service chiefs admit financial difficulties in some satellite areas and other of the more exotic space projects. Should breakthroughs occur in these areas, reprogramming within the service concerned or the DOD emergency fund can provide ample funds for most work during any given fiscal year.

Heat problems and vibration . . .
which have been major causes of trouble in earlier missile tests, are rapidly being minimized as research and development broadens. As missilemen point out, something is learned from every firing, regardless of the outcome.

There have been no official reports . . .
of a successful recovery of a *Thor* or *Thor-Able* nose cone. Sources close to the projects state that at least two instrument packages have been recovered intact. Data obtained indicated that the cones—from their apogee of about 500 miles through the re-entry phase—performed perfectly.



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industry countdown

Project *Saturn* . . . the Rocketdyne effort to cluster a group of its X-1 engines for 1½ million lbs. thrust, is on a "crash" basis. However, although the X-1 is the latest simple, reliable and fully tested Rocketdyne model of a 165,000-lb.-thrust liquid engine, and incorporates design features gained through the *Jupiter/Thor* programs, don't expect success for many, many months. Too complex a problem.

***Jupiter* re-entry data . . .** gained from the nose cone developed by Cincinnati Testing Labs' impressed ARDC officials at their first briefing on the subject—by CTL (not Army) two and a half months after the fact. Air Force is now believed to be considering combining the CTL ablation approach with its own beryllium/heat sink approach to the *Minuteman* ICBM. The *Jupiter* cone burned off less than ½″ of the plastic laminate outer covering out of a total of 3″.

First *Hound-Dog* . . . flight control system has been completed and delivered by Autonetics division of NAA to the firm's missile division. North American says the all-transistorized unit uses the "latest" type of etched-circuit electronic designs.

Weapons system reliability . . . and quality control are scheduled for two of the 12 day-long production forums at the National Aeronautical Meeting, SAE, which runs to October 4 in Los Angeles (see also p. 12). Other subjects to be covered by the meet include high temperature materials, test equipment, production rates, procurement, costs, sandwich construction, ground support equipment for missiles and "exotic materials and processes."

The fate of Fairchild's . . . J83 turbojet engine hangs on the Air Force's decision regarding the decoy *Goose* missile. The *Goose* is powered by the J83 and successful tests at Cape Canaveral indicate that AF will decide to turn out substantial numbers of the bird, thus bringing the J83 into production.

Large solid-propellant . . . rocket motors were the subject of discussion when Thiokol v.p. J. S. Jorczak was asked about the recent firing of his company's 450,000-lb.-thrust motor at Redstone Arsenal. Replied Jorczak: "You mean our small one?" Meanwhile, some indication was seen at Redstone that a solid motor utilizing boron fuels would soon be fired. Thrust exceeds a half million pounds.

A rocket nozzle . . . has been produced by The Norton Co. which is capable of withstanding 3,200° F. The hardware is part of an RMI drone project.

Drastic departure . . . from conventional rocket engine design appears to have occurred in the *Polaris* program. The casing, although meeting all strength requirements, gives the deceptive appearance of being "flimsy." The first stage casing is 110″ long by 54″ and the second stage measures 54″ in diameter and 47″ in length.

Army has cancelled *Dart* . . . the offspring of the French SS 10, and has terminated research and development on the bird. Aero Physics Development Corp. of Santa Monica had the R&D contract and production was by Utica-Bend Corp. Value of the production contract was placed at $16.5 million. Cancellation was attributed to duplication of the *Dart's* job by other missiles.

Armed Services procurement . . . Regulation 35 has been revised to establish fee limitations on cost-plus-fixed-fee subcontracts. The new ruling provides that all such contracts limit the payment of fees to 10% of the estimated cost, exclusive of additional fee in the case of any subcontract for experimental, developmental or research work. In all other types of subcontract, payment would be limited to 7% of the estimated cost.

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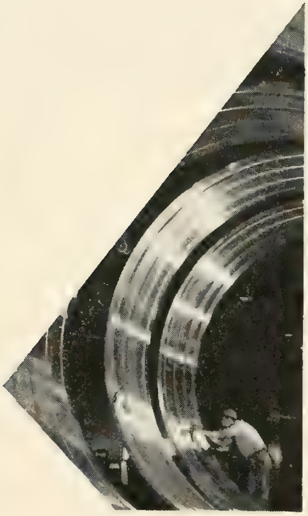
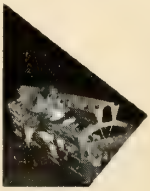
For more information, write to Lukenweld, 152 Lukens Building, Lukens Steel Company, Coatesville, Pennsylvania.





Plasma Jet Thrust Up; A Space Milestone

Laboratory Success Shows Higher-Power Engines Await Controlled Fusion

by Raymond M. Nolan

Plasma jets are now being operated in the laboratory at thrusts of up to two pounds.

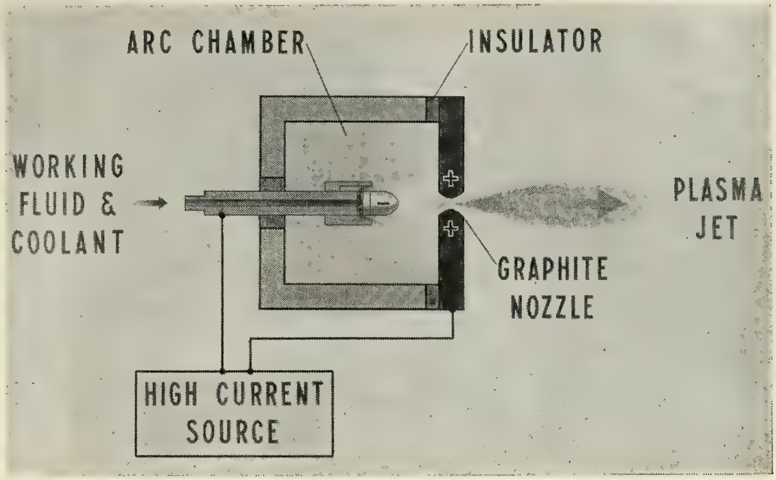
This is the report from Plasmadyne Corporation of Santa Ana, Calif. A spokesman for Plasmadyne said that thrusts of this magnitude could be used for attitude control of satellites or space vehicles with not much more provision for power than is now planned for TV scanning satellites.

This marks the first step into the new electric forms of propulsion that many feel are necessary before space can be explored.

Plasma jets have been studied for many years, both in this country and in Germany—and presumably in the USSR. They are intriguing to scientists because of the relatively high temperatures they entail and the high (600-and-up seconds) specific impulses they give for propulsion. The main drawback has been the enormous amount of power required, because the most practical way of operating a plasma jet has always been in an electric arc.

To generate a plasma (defined as a state of matter consisting of highly excited free electrons and positive ions), an electrical potential is first set up across a gap bounded by an anode and a cathode. The cathode releases an electron stream which ionizes some of the atoms and molecules in the gap. In this way, additional electrons are freed, and collisions with atoms become more frequent.

Thus, the total kinetic energy of the particles in the gap continues to increase, with a corresponding increase in temperature. Finally, two sub-atomic streams are flowing—electrons to the anode, positive ions to the cathode. This is the plasma state. Light quanta are given off when electrons and ions recombine to form neutral atoms. If the kinetic energy imparted to the electrons is sufficiently high, the particles will begin knocking positive ions off the anode where they proceed to the cathode. The stream of hot eroded ions constitutes the arc.



IDEALIZED plasma jet is illustrated in NACA sketch.

Propulsion units of future

Plasma jets have two principal uses in the missile field today—they are seen as propulsion units of the future, and they are valuable tools for investigation of aerodynamic heating in re-entry problems, where the temperatures involved give a good picture of what happens to materials when vehicles come back into the atmosphere. However, their greatest potential lies in the propulsion area.

It is already a well-known fact that we are pushing the state of the art in chemical propulsion. The weight of the fuel which must be carried for long voyages just about rules out chemicals for propulsion to any of the other planets—or even to the moon if we intend to land and then return.

Several ways are under investigation for propellants of the future—nuclear engines, plasma jets, ion engines, and the presently far-off photon propulsion. All of these are theoretically feasible, but the over-riding consideration for all but the nuclear is electrical power. In the case of the nuclear engine, it is the weight of the engine, fuel, shielding and conversion device.

Electrical power is, and will continue to be, the most serious drawback to space travel. We have not as yet developed any way to tap the almost limitless electrical energy which is present in outer space, so most programs today are concerned with means of developing the power within the vehicle.

Power from fusion

Power for the two-pound thrust engine developed by Plasmadyne is not too much of a problem, because it is planned for use as a control device and for relatively short-term periods. However, power for larger engines or for longer times will be difficult to come by. About the only method now considered possible is that of controlled thermonuclear fusion, but here again the problems are many.

Fusion needs fantastically high temperatures to maintain a sustained flow, but to date, we, the English, and the Russians have only been able to create temperatures of a fraction of those needed—and these for extremely short periods. When someone does solve the power problem, we will have taken a giant step forward.

Scientists on AEC's Sherwood program (code word for the controlled thermonuclear program) are working with a goal of 100 million degrees, the temperature believed necessary for a self-sustaining thermonuclear reaction. This takes the form of a magnetic pinch effect where the electrically charged particles are controlled by magnetic lines of force, supplied by coils or by currents passing through the plasma itself.

The magnetism must be strong enough to contain the plasma and has to be self-variable so that it can adjust to changing temperatures. The pinch effect is obtained by using the phenomenon of attraction of parallel currents. Discharges of heavy parallel currents pinch the atoms of the plasma together and suspend them in a thin line away from the container.

When a pinch is sustained for significant periods of time, researchers believe that they will have the temperature necessary for a plasma jet which will have an energy output far greater than the power necessary to produce the pinch.

Ten lb. thrust equals 25,000 mph

However, the two-pound thrust en-

(Continued on page 30)

Chemists Look To Missile Money

Meeting Stresses Need For New Fuels, Better Solids

m/r report

CHICAGO, ILL.—Over 14,000 chemists and chemical engineers convened here at the 134th national meeting of the American Chemical Society held this month. Dr. Howard L. Pilat of the Celanese Corporation of America sparked the confab in his address: "New Impulse to Profits: An Appraisal of Chemical Opportunities in Rocket and Missile Developments".

"The chemical industry should look to the missile spending area for R&D funds," pointed out Dr. Pilat. However, the chemical industry will find no welcoming committee inviting them into missiles; fierce competition will be offered by diverse industries such as aircraft, automotive, metals, and even foods. The trend to solid rockets should be a good opportunity for chemicals to enter the missile field.

• **Chemical needs**—(1). Non-toxic, storable, non-corrosive oxidizers with performance comparable to LOX.

(2). New liquid fuels giving higher performance, and better handling than experimental fuels.

(3). Better solids.

Another area for chemicals is the growing field of synthetic lubricants, hydraulic fluids, and coolants for jet aircraft, missiles and spacecraft. J. S. McClure of the Oronite Chemical Co., San Francisco, Calif. told of developments toward such high temperature fluids.

In order to eliminate operational difficulties, particularly at high temperatures, near pharmaceutical manufacturing conditions prevail for the new synthetic lubes. Both the X-10 and the *Navajo* test missiles used a silicate ester high temperature hydraulic fluid. The X-15, also, will use synthetic lubes that will prove feasibilities for the forthcoming *Dyna-Soar*.

At present, sales of lubes are made to primes and subs. However, when aircraft (such as B-58) and missiles become operational, lube sales will be made directly with the service involved. Products are now in the nature of a low-volume, specialty item. High temperature hydraulic fluids now offered are:

Company	Products
Bray Chemical Co.	Silicate ester fluid
General Electric Co.	Versilube F-50
R. M. Hollingshead	Silicate ester fluid
Monsanto Chemical Co.	OS-45-1
Oronite Chemical Co.	8515 & 8200 fluids

Petroleum-based hydraulics are limited to temps of 250-275 F. Research on synthetics is aimed at service at temps of 700-1,000 F.

Esters of dibasic acids and polyglycols do not meet temp requirements. Silicones have poor steel-steel lubricity. Organic silicate esters have poor hydrolytic stability. Stable alkoxy disiloxanes, however, have appeared. The long evaluation period for systems, however, will require chemical manufacturers to get in with their new lubes soon or find conventional materials being used.

• **Requirements**—What will the lube requirements for missiles be? It may follow the jet engine pattern outlined by C. T. Stone of Esso Standard Oil Co. One jet engine lube (LIL-L-7808) will be a market of over one million gallons a year for a product that originally cost near $10 gallon.

By 1960 synthetic lubes will soar to four million gallons per year. Consumption of oil in jets is small, so that the figures may be applied to a large number of one-shot missiles. Meanwhile evaluation costs and time requirements for testing are going up. Manufacturing the new fluids after successful testing can also be quite a problem.

Thermal degradation of new plastics material was also reported. The Pyrotechnics Lab of Picatinny Arsenal reported on its work on styrenated polyesters for high-temperature ordnance applications.

Union Carbide reported on an epoxy resin combination that is stable to exposures of 250 C for at least 100 hours. Dicyclopentadiene dioxide forms the basis of these high-temp epoxies.

NBS outlined its work with an amidine fluorocarbon copolymer that has good elastic properties and promises greater thermal stability above 500 C than the more common polytetrafluoroethylene polymer. A complixating factor is the 20-30% volatalization which occurs initially but which may be overcome by removal of impurities.

According to J. W. Cole of the University of Virginia, no ideal antioxidant has yet appeared to protect lubes against high temperature degradation. His statements are also somewhat applicable to plastics.

Automotive Engineers To Get Missile Briefing

Add one more old-line professional society to the list of those emphasizing missiles and space when the Society of Automotive Engineers opens it Annual Aeronautic Meeting in Los Angeles, Sept. 29-Oct. 4.

Although the total number of "production forums" is down from the 1957 meeting, two classified sessions involving missiles are slated, as are two open meetings for a total of four sessions and 12 papers directly involving missiles. There will also be one panel forum on "Ground Support Equipment for Missiles."

• **Classified sessions**—In the first of two classified missile sessions (Confidential), missile auxiliary power systems will be discussed by P. I. Wood and B. M. Wilner, Aerojet-General, "Performance Capabilities of Turbine Driven APS"; Bernard Clifton, Bendix Aviation, "A General Survey of Missile Electronic Power Supply"; and D. A. Rains, Ramo-Wooldridge, "Secondary Power for Space Flight".

The second classified session will cover missile engineering with papers by C. S. Ames, "Highlights of the Atlas ICBM Development and Flight Test Program"; R. S. Gardner, Wyle Labs. and Elmer R. Easton, Wyle Associates, "A New Concept of Missile Reliability Assurance Through 100% Testing of Airborne Propulsion Components"; and W. A. Knittle, Rocketdyne, "Liquid Propellant Vernier Engines (Design and Application)".

• **Open sessions**—Open sessions include missile guidance and control with papers by C. R. Faulders, North American Aviation, "Low Thrust Rocket Steering Program for Minimum Time Transfer Between Planetary Orbits"; A. D. Wheelson, Ramo-Wooldridge, "Mid-course and Terminal Guidance"; and E. R. Buxton, Autonetics, "Automatic Landing Flare System for Aircraft, Missiles and Space Vehicles".

Papers on missile handling and storage will take up another open session with F. P. Price, Convair-Pomona, "Terrier Field Service Problems"; H. J. Ide, Douglas-Santa Monica, "*Nike* Hydro-Mechanical Maintenance Problems"; and R. W. Manley, Hughes, "Maintainability of the *Falcon* Missile System".

Other subjects of general interest to the missile field will be "High Temperature Materials", "Shock and Vibration" and "Aerodynamic Labs and Test Facilities".

In addition to the technical sessions, an engineering display will be held at the Ambassador with 120 booth spaces reserved by about 90 firms, it has been reported.

Defective Valve Stymied *Vanguard* Attempt

by Norman L. Baker

X minus O, and Holding

CAPE CANAVERAL—Once again the hard luck *Vanguard* program has suffered a severe prestige setback. SLV-3, loaded with an Army Signal Corps "Weather Eye" satellite package refused to leave its pad during a precedent-breaking countdown on its first try last week.

Countdown began 6 hours before scheduled lift-off time. All proceeded well until the last sixty minutes. A series of minor holds stretched the launch time from 9:30 A.M. to 11:17 A.M. Major difficulties were experienced in the range instrumentation checkout. After a hold at X minus 36 seconds, the count proceeded smoothly to the "X minus O, rocket 1391 at zero."

The first stage engine responded instantly to the ignition signal. Smoke and steam poured from the deflector plate as thrust build-up began. Approximately five seconds later a burst of off-color, unwanted flame appeared in the vicinity of the engine—then the announcement, "X minus zero and holding." Moments later the countdown was moved back to X minus 35 minutes to reload. Within minutes SLV-3 was pronounced scrubbed and the gantry slowly moved back into position. Official announcement for the failure—malfunction triggered an automatic cutoff.

Preliminary investigations indicate that a defective valve stopped the flow of one of the propellants a fraction of a second from maximum thrust build-up. Shutoff was activated by a fail-safe device as a result of engine starvation.

Disaster in the form of total rocket destruction was averted by the launch stand's new hold-down devices. Four arms similar to the two hold-down arms employed in the *Atlas* launch system, were installed on the pad shortly before this last test. The arms are designed to hold the *Vanguard* secure until almost total thrust is developed (27,000-lb) in winds up to 30 mph. Wind velocity during the countdown varied from 10 to 20 mph. If the vehicle had cleared the arresting arms before the thrust decay it would have toppled to its destruction.

NRL informed m/r before the unsuccessful try that the *Vanguard* crew had checked, rechecked, modified, recycled and de-bugged the vehicle until they felt no further improvement was possible. Confidence was supreme hours before the attempt—odds were considered one in four for success. After the try, a spokesman in dejection summed it up with, "They did the best they could."

Another attempt is not expected for several days. The rocket will have to be cleaned throughout and a complete checkout made on instrumentation and wiring. NRL is optimistic that the rocket can be made ready for its next try this week.

- **Satellite details** — The SLV-3 Weather Eye satellite will measure the global distribution and movement of cloud cover over the daylight portion of the orbit and relate it to the over-all meteorology of the earth. Incorporated in the satellite package are two photocells, sensitive to red and near-infrared for scanning the surface of the earth and the cloud systems. Since the tops of clouds and the earth's terrain have different reflectability levels, light striking the photocells will cause changes in electrical impulses in direct proportion to the light intensities. Clouds reflect 30 to 80% of the light striking them, while land masses reflect 15 to 20%. The near-infrared sensitive qualities of the photocells will provide the best possible contrast in detecting land, cloud and water masses.

Signals from the photocells will be recorded on a 75-foot loop of erasable tape. The signals from the tape will be interrogated by a command receiver in the satellite during each orbit. The information collected will be relayed in one-minute transmissions to the Minitrack stations on the 108.03 megacycles frequency and re-recorded.

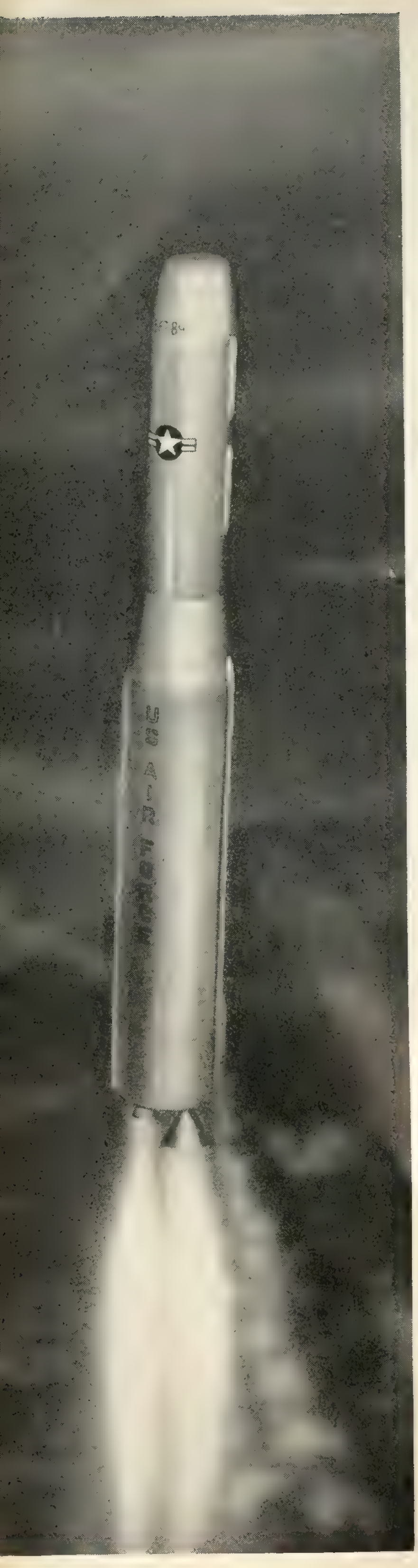
During the first 24 hours of operation, the satellite will not be interrogated in order that a scale of reference may be established at the equilibrium temperature. In addition this will allow time for correlation of orbit, time, position and cloud cover information. As the satellite progresses from light into darkness it will be turned off by a solar-cell activated switch reducing the drain on the power of the mercury batteries. The same switch will activate the instruments when the satellite again enters the sunlight.

Instrumentation and batteries account for approximately one-half of the 21.5-lb payload. Instrumentation was developed by the Army Signal Research and Development Laboratory.

Scientists believe that the satellite will be able to recognize hurricanes and typhoons and the severe storms which breed cyclones and tornadoes. Ultimately it may be possible to produce facsimile weather maps.

This experiment will make possible a measurement of the total earth cloud cover, and will allow meteorologists for the first time to develop a good theory on the flow of heat through our atmosphere, and thereby improve long range weather predictions. It may even be possible to reproduce an image with enough identification to distinguish types of clouds, lakes, mountain ranges and other features.

MEMBERS OF THE *VANGUARD* TEAM meet with Dr. John P. Hagen, director of Project *Vanguard*. Left to right: Dr. J. W. Siry, head of Theory and Analysis Branch; Mr. D. G. Mazur, manager of the *Vanguard* Operations Group, PAFB, Florida: Mr. J. M. Bridger, head of the Vehicle Branch; Cdr. W. E. Berg, Navy Program Officer; Dr. Hagen; Mr. J. P. Walsh, Deputy Project Director; Mr. M. W. Rosen, Technical Director; Mr. J. T. Mengel, head of Tracking and Guidance Branch and Dr. H. E. Newell, Jr., Science Program Coordinator.



Titan: "Most Advanced" Missile

Titan, the Air Force's back-up ICBM, incorporates within its design the most advanced rocket technology available in the free world. Its two-stage configuration is the near-optimum in the critical mass-ratio parameter. This makes it possible to send a warhead equal to the destructive potential of the missile's forerunner *Atlas* the same distance, yet with a drastic reduction in total take-off thrust.

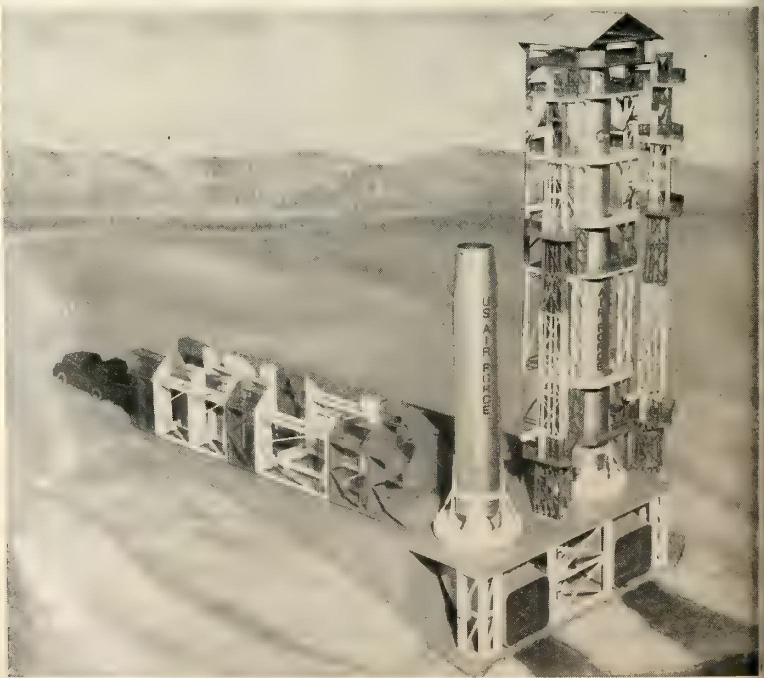
Overall weight of the *Titan* is approximately 10 tons less than its sister weapon, *Atlas.* Take-off thrust is 300 to 330,000 pounds, compared with 360 to 390,000 pounds for the *Atlas.* While *Atlas* employs three engines for generating the necessary power, *Titan* will be pushed with two engines. The *Titan* engines are very similar to those used by the *Jupiter, Thor* and *Atlas* (boosters).

- **Test and development**—The clustered first-stage engines, developed and manufactured by the Aerojet-General Corp., have received extensive captive testing, singly and paired, at Martin-Denver's test facilities in Colorado. Engines are gimballed three to five degrees for obtaining major attitude control. Four vernier engines mounted on the second stage, at the junction of the first and second stage, provide precise attitude and thrust control. Burning time of the first stage is estimated to be between 140 to 160 seconds.

A bell-nozzled rocket engine developing a thrust of 60,000 pounds propels the second stage after separation from the first stage. The four vernier engines continue to thrust throughout the second stage portion of the flight and for several seconds after the sustainer's burnout. Burning time of the final stage is approximately three minutes.

First stage has an overall length (measured to the exit area of the rocket nozzles) of about 53.5 feet, and a diameter of about 10.5 feet. Second stage has an overall length of 37 feet, 8 inches (frame length of 32 feet, 9 inches); and a diameter of 8 feet, 3 inches.

The first complete *Titan* missile has been delivered to the Cape Canaveral test range for evaluation. The two stages have received extensive captive tests at the prime contractor's test facilities at Martin-Orlando before delivery to the AFMTC. This first missile will not be flight-tested, but will serve only as a static-test vehicle. The first two launch pads have recently been completed and are expected to go into service with flight missiles within the next few weeks.



MODEL of *Titan* ICBM assembly-erector-gantry crane for the test at Cape Canaveral. LEFT, *Titan* in simulation of firing.

ee World

• System evaluation—The *Titan* guidance system, developed by Arma, is probably one of the best inertial guidance systems in existence, although it will not fly with the first, or even the tenth, test version of *Titan*. Reason: early versions of the missile were programmed to use the more positively-controlled radio inertial guidance developed by Bell Telephone Labs for *Titan* and *Thor*.

Later versions still will not have equipment available because of the Air Force decision not long ago to use Arma guidance in the production *Atlas* missiles. The BTL radio inertial guidance, incidentally, is very similar to the type which General Electric built for the *Atlas,* and which is now being phased out so that the *Atlas* missiles will be all inertial.

The Arma system, which will appear in production versions of both liquid-fueled ICBM's, consists of a control central, a guidance computer, a stabilized platform with two two-degree of freedom gyros, and three vibrating wire accelerometers.

Overall weight of the system is about 500 lbs., and it is built with techniques far in advance of most other systems, even though one Arma official describes it as the "Model T" of Arma's guidance concept.

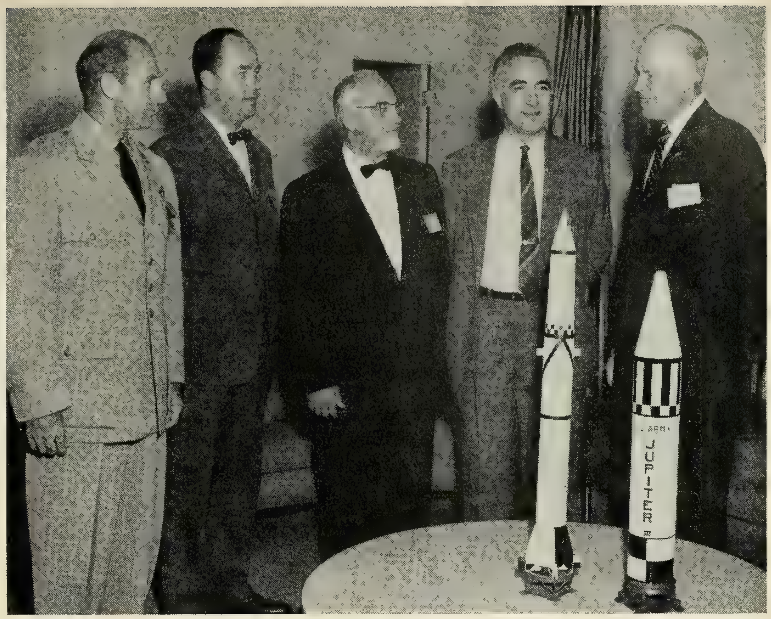
Arma has already standardized the 6 by 9-inch circuit cards, so that less than ten types are used in the three-deck, 180 lb. guidance computer. Miniaturization efforts are already being applied to reduce the computer to 60 and then 20 lbs. respectively.

The 20 lb. version will feature ceramic discs with sub-miniature components stacked on a 9-inch diameter card, and surrounded on its periphery by a magnetorestrictive delay line. With every pound saved in the instrument section translated into more payload or less fuel, Arma engineers feel that miniaturization is their most important product.

• Launching—One major difference between the *Atlas* and the *Titan* will be in the launching method.

The firm of Daniel, Mann, Johnson and Mendenhall, Los Angeles constructors and engineers, are reportedly working on plans for "hard" launching sites, a formidable problem with liquid-fueled missiles.

The toughest part of the "hard" complex will be the storage and rapid pumping facilities for liquid oxygen, although there are some reports that a missile on "ready" will be fueled and have its LOX continuously recirculated.



ROCKET SOCIETY chiefs confer with speakers. (Left to right) Gen. H. Boushey, Jim Harford, G. Edward Pendray, George Valley, Harlan Hatcher (president, U. of Mich.)

ARS Reports R&D Up, Hardware Trimmed

DETROIT—Some 1,000 members of the American Rocket Society met here Sept. 15-18 to discuss missile production problems, auxiliary powerplants, and the impact of space flight on the nation's industries.

Biggest news to hit the meeting was North American Aviation's announcement of a cluster rocket engine to deliver 1.5 million lbs. of thrust (m/r Sept. 22, p. 13). This is an apparent back-up for the one megapound single chamber engine that Rocketdyne is to design for USAF.

According to Lt. Gen. Arthur G. Trudeau, Army's chief of Research & Development, the 1.5 megapound engine will be employed under ARPA or NASA-designated programs for space and satellite use only. Trudeau thought that such an approach would do much to reduce the usual long years from "womb to boom" in most missile programs.

Most engineers, including Rocketdyne's, differ considerably as to possible production times of either engine, ranging from one to three for the cluster and three to five for the single chamber. Beyond these engines, Rocketdyne sees large manned satellites (figures) which would require 6-15 megapounds of lunching thrust.

• Reliability-production problems—Most unclassified papers were concerned with production problems in the complex art of missile manufacture.

The liquid propellant *Redstone* missile, with an engine (the A-7) in the 75,000 lb. thrust class, has attained an overall engine reliability of about 96%.

This may not be high enough for anti-missile use. Even the solid propellant *Nike-Zeus,* though its powerplant will have almost 100% reliability, will have inherent detection and guidance problems. For this reason, Dr. George E. Valley, chief USAF Scientist, does not hold out much hope for "antis".

Other factors may also obsolete missiles. Detroit, for example, was startled to hear that the *Dart* anti-tank missiles would no longer be produced at the Curtiss-Wright subsidiary plant at Utica, Mich. The Army cancelled the $16.5 million contract, presumably because the European allies were able to produce cheaper, more reliable, and more versatile AT rockets.

• Space-flight forum—Brig. General Homer Boushey, first director of Advanced Technology for USAF, said that there would be a gradual shift from military aircraft and missiles to military use of space weapons. The trend would be from the aeronautical industry to the astronautical industry.

K. J. Bossart of Convair-Astronautics' Technical Division emphasized that for a long time to come most efforts would be for R&D rather than manufacturing. Reliability and long-life will be major goals. According to Dr. Valley, booster rockets for space operations would seem to require standardization.

missile business

Labor costs—in the form of wages, anyway—will go up this year. That's obvious from the demands of labor unions already on record. And it won't be easy for management to counter these demands—the labor leaders are perfectly well aware of the improving economic picture, better sales and improving profits.

The jump could run as high as 10 cents an hour for manufacturers in the missile field, following hard on what the steel industry has already okayed. And from those agreements you can read the place where the changes will be: improving established benefits—bigger premium pay for week-end work, vacation provisions.

And white-collar wages will have to go up, if the men in the shop get theirs. Best guesses are that white-collar (and blue-collar unorganized workers) should average about a 4% hike.

Productivity may be a bright spot in this picture. Official measurements are necessarily inaccurate, but indicate a rise for production workers of about 4% in 1958, and further rises due in the spring.

More business for small business is expected to result from those changes in government procurement laws recently signed by the President. Gist of the changes is that "open market" purchases, until now limited to between $500 and $1,000, are raised to $2,500 for all agencies. Expectation is that this will permit more small orders that can readily be filled by small business firms.

How much missile business means to many types of business activity is indicated by only a partial list of developments last week. Among new plants, for instance, there were these: Linde Co. (Division of Union Carbide) broke ground for a multi-million LOX and nitgrogen plant at Pittsburg, Calif.; Bendix Industrial Controls Section (of Bendix Aviation) will increase its floor space at Detroit by 60%; H. B. Fuller Co. plans a 14,300 sq. ft. addition to its adhesive plant in Fairfax, Kansas; Magnetic Amplifiers, Inc., has opened a new plant in New York, upping its manufacturing space by 50%.

Good news for stockholders came out of financial reports last week. The Siegler Corp., Los Angeles (which recently merged Unitronics Corp. into its corporate structure) reported record sales of $72.9 million for the 1958 fiscal year, a net of $1.2 million. Telecomputing Corp., Los Angeles, showed increased sales of $21 million and net income of $542,460 for the first nine months of 1958. Clary Dynamics Division (of Clary Corp., San Gabriel, Calif.) listed more than $500,000 in new order for its valves, gyros and missile components, in August alone.

Perkin-Elmer Corp., Norwalk, Conn., whose engineering and optical division has long been a leader in missile range instrumentation, optical systems and the like, is expanding its organization with a new regional office in Monrovia, Calif. Reason is revealing: "We have seen many new names and faces in the military weapons system field," said C. W. Miller, division general manager. "Many of them are locating in the west."

Boost in mail rates (up from 1 to 2 cents per piece for bulk mailings) due Jan. 1 will cut down on businessmen's mail, somewhat. Mail-selling won't be cut out, but the rate jump will mean drastic pruning of lists now being used.

contract awards

NAVY

By Office of Naval Research:

University of Cincinnati, received $54,000 for orbit calculators for use in connection with Project *Vanguard.*

Polytechnic Institute of Brooklyn, Brooklyn, N.Y., received $35,000 for study to determine the feasibility and design of a wind tunnel to hypersonic, high-enthalpy, low-density gas flows.

AIR FORCE

By HQ, AFMTC, ARDC:

Radiation, Inc., Melbourne, Fla., received $100,000 for increase in funds.

ARMY

Ordnance District, Philadelphia:

Western Electric Co., Inc., New York, N.Y., received 25 contracts totaling $3,213,802 for *Nike* spare parts and components.

Douglas Aircraft Co., Inc., received $65,193 for *Blue Streak* and emergency spare parts.

University of Pittsburgh, Pittsburgh 13, Pa., received $27,243 for basic research entitled "Low energy nuclear and electron physics."

Spitz Laboratories, Inc., Yorklyn, Dela., received $49,652 for development, design and construction of lunar flight models.

RCA Service Co., a div. of Radio Corp. of America, Cherry Hill, Delaware, received $411,944 for installation, repairing, modifying and developing electronic and related equipment, guided missile program.

By Engineer Division, New England, Corps of Engineers, Springfield Area:

Hartford Oil Heating Co., Hartford, Conn., received $8595 for rehabilitation of existing heating system, group headquarters, *Nike* battery.

Blount Brothers Construction Co., Montgomery, Ala., received $3,245,869 for construction of SAC missile facility.

By Boston Ordnance District:

Raytheon Mfg. Co., Andover, Mass., received $2,085,530 for *Hawk* missile repair parts.

By Ordnance District, Los Angeles:

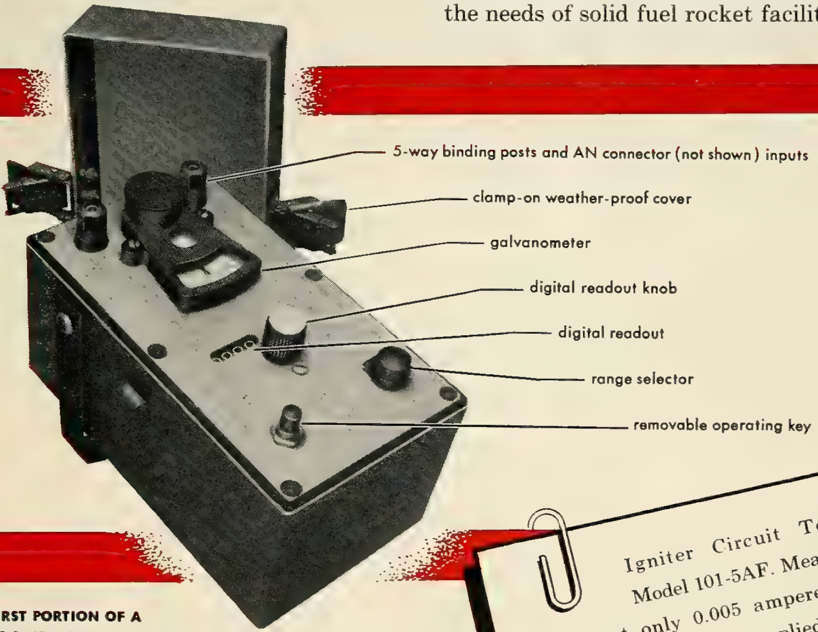
Firestone Tire & Rubber Co., Los Angeles, Calif., received $72,998 for procurement of emergency and *Blue Streak* repair parts.

HOW TO TEST SOLID FUEL ROCKET IGNITERS

. . . safely!

IN order to prevent misfires with subsequent costly delays, most solid fuel test facilities now use an officially approved ALINCO Igniter Circuit Tester to test their igniters during manufacturing and prior to firing. The 101-5AF, the latest model of this field-proven instrument, is portable, easy to operate, accurate, and safe. The maximum output current is only 1% of the minimum firing current of a single squib, and the instrument has a measuring range to 30 ohms. It accurately measures igniter and line resistance, quickly detecting shorts, open, and intermittent circuits. Reading the instrument incorrectly is practically impossible with its four-numeral digital readout.

THE UTILITY built into this instrument typifies that of other ballistic instrumentation supplied by ALINCO for solid fuel rocket facilities. Whether a small portable instrument such as the 101-5AF, or a sophisticated system such as the Type K-4 Ballistic Computer, each instrument is carefully and specifically designed to meet the needs of solid fuel rocket facilities.



Igniter Circuit Tester, Model 101-5AF. Measuring current only 0.005 ampere. This instrument is also supplied as the Model 101-5AP, for rack mounting.

HERE IS THE FIRST PORTION OF A LIST OF OVER 100 USERS OF THIS TESTER

Aerojet-General Corporation, Azusa
Aerojet-General Corporation, Sacramento
Aerolab Development Corporation
Aerophysics Development Corporation
Allegany Ballistics Laboratory
Anniston Ordnance Depot
Applied Physics Laboratory
Atlantic Research Corporation
Avion Service Corporation

Bell Aircraft
Bermite Powder Company
Black Hills Ordnance Depot
Blue Grass Ordnance Depot

C.I.T., Jet Propulsion Laboratory
Canadian Arsenals Limited
Catalyst Research Corporation
Charleston Naval Shipyard
Chrysler Missile Operations
Convair, California
Cooper Development Corporation

Department of Defense Production
Detroit Arsenal

Eagle Picher Company
Edwards Air Force Base
Elgin Air Force Base

Fairchild Guided Missiles Division
Fort Monmouth, New Jersey

General Electric Company, Philadelphia
General Electric Company, Burlington, Vt.
Grand Central Rocket

Holex, Inc.
Holloman Air Force Base
Hughes Aircraft Company

Jefferson Proving Ground

Letterkenny Ordnance Depot
Lockheed Aircraft
Librascope, Inc.

Martin Company
Mason & Hanger, Silas Mason Company
McCormick Selph Associates
Minneapolis-Honeywell Regulator Company

ALINCO

SPECIALIZING IN SOLID FUEL INSTRUMENTATION

Allegany Instrument Company, Inc.

CUMBERLAND, MARYLAND AND GRANADA HILLS, CALIFORNIA

Tests Prove Out Missile-Sub Guidance

Navigation, the key to the success of the *Polaris* missile and the entire fleet ballistic missile system, is now undergoing the most rigorous tests and evaluation aboard the USS "Compass Island," which from outward appearances very much resembles any ordinary merchant vessel.

In the "Compass Island," however, the Navy has assembled the most amazing array of electronic navigational equipment ever put together. Important among these systems is the Ship's Inertial Navigation System (SINS), a miniaturization of the USAF system which enabled the *Nautilus* and the *Skate* to make their polar voyages under the ice cap.

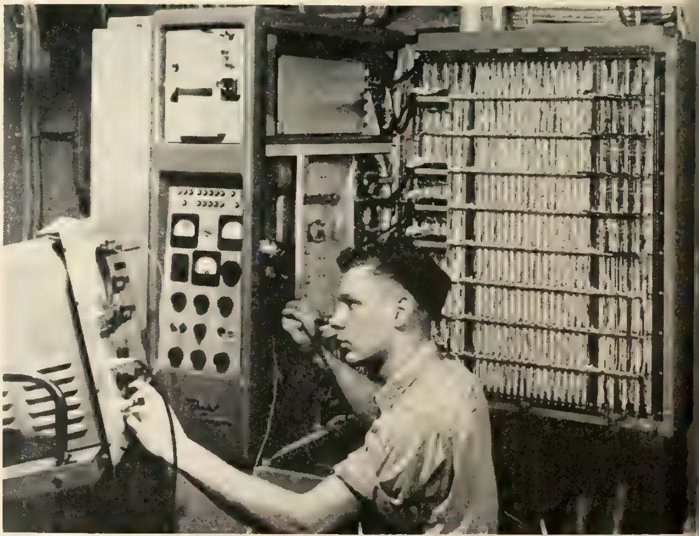
The "Compass Island's" inertial guidance system permits a vessel to keep track of its movements and more accurately determine its position than has been possible before, independent of any shore-based aids. In addition, the ship is carrying out evaluations of a new type star tracker (Farrand star tracker), computors and a variety of gyros, compasses, and other mechanical equipment used in navigation systems.

The Navy has drawn on all segments of American industry to develop the revolutionary navigational equipment. Among companies working on the fleet ballistic missile navigation system, which can be adapted to other type vessels, are the Bendix Aviation Corporation and North American Aviation.

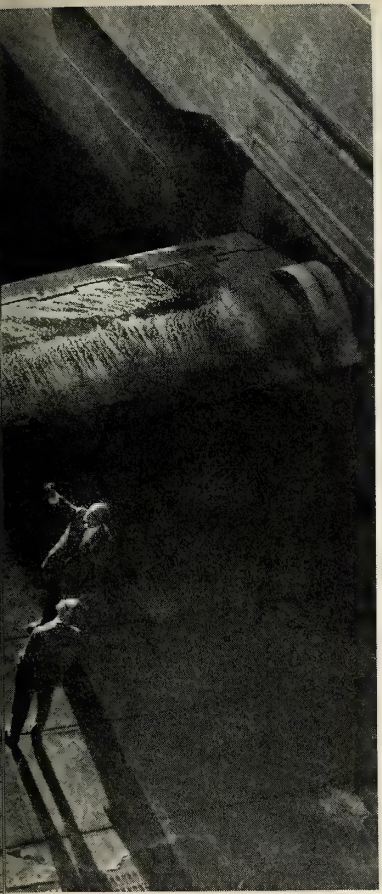
While the "Compass Island" is carrying out the work on the navigational system, a sister ship, the "Observation Island," is being used for the preliminary tests of the firing of the *Polaris* missile itself. Navy spokesmen have indicated highly satisfactory tests to date on all components of the FBM system, which is currently scheduled for readiness status with the fleet by 1960.

NORMALLY, STABILIZER COUNTERACTS sea movement. Here, it demonstrates effectiveness by creating man-made roll.

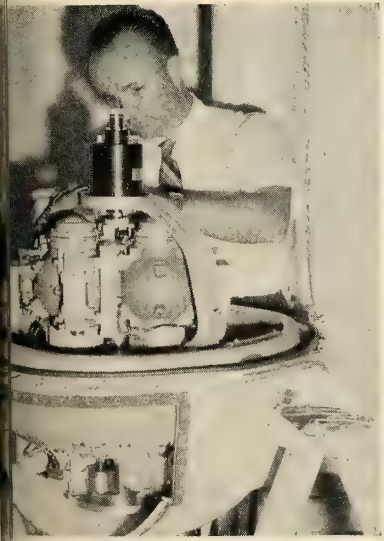
CAMERA ASSEMBLY of the Farrand star tracker is important part of FBM system.



CIRCUITS OF COMPUTER, G-15D by Bendix, checked by Navy technician. Equipment is used to compute star fixes and can supply other navigational data.



. STABILIZERS located below the water-
n each side of ship assist in tests of navi-
al equipment, essential for the fleet bal-
missile sub in locating firing position.



LE ELEMENT of the ship's inertial navi-
system is adjusted by engineer.

Business Group Hears Review Of Space, Missile Program

York, Holaday Outline Plans To Defense Orientation Conference; Stress R&D Importance In Future

by Donald E. Perry

WASHINGTON—Polar regions for pace vehicle launchings . . . exaggerated importance of nuclear rockets . . . four-ton satellite fueled by hydrogen-fluorine . . . changes in *Dyna-Soar* program . . . mating of *Eagle* with *GAR-9* . . . state of art passes *Rascal* by for big production.

These were major points brought out by Dr. Herbert F. York, chief scientist for Advanced Research Projects Agency; and Guided Missiles Director William M. Holaday, before the Defense Orientation Conference Association at the Pentagon. The association is made up of industry, business, labor, and other national leaders who periodically receive briefings on national defense.

• **Space via poles**—Dr. York apparently concurs with a theory advanced recently by Prof. Fred Singer of the University of Maryland, (m/r Sept. 1, p. 23) which postulates that particles in the radiation belt discovered in the *Explorer* program are protons, which spiral around magnetic lines of force. Thus the maximum concentration of radiation is reached at the equator, at about 1½ earth radii (6,000 miles), and at 10 earth radii, the belt will end gradually. Singer believes there is a complete absence of radiation at the poles, and escape to space may have to be made thru polar region launchings.

Dr. York said the most significant thing about the radiation belt was that its discovery "was totally unexpected." Failing to achieve adequate shielding for space vehicle occupants (he estimated one ton of shielding weight per person), "the other possibility is to go out from regions within 20 degrees around the pole."

While establishment of U.S. polar launching sites may still be just a gleam in the eyes of official Washington, Russia reportedly (m/r July 21, p. 8) is establishing major missile handling and launching capabilities in the Antarctic at its big Mirny base.

• **Nuclear rockets**—Reviewing ARPA's propulsion programs, Dr. York commented that "the necessity for nuclear rocket engines has been somewhat exaggerated," and while they are important, they are not essential for putting objects into space. He said "special staging" on either *Atlas* or *Titan* (expected sometime next year) would allow 1½ to 2 tons to be placed in orbit. If upper stages use fluorine-hydrogen combinations, three to four ton payloads can go into orbit, he added.

• **Dyna-Soar**—Dr. York confirmed to m/r that ARPA is taking a serious look at the *Dyna-Soar* program. Other sources indicated that Defense Secretary McElroy reportedly soon can be expected to assign ARPA responsibilities in the program. However, ARPA reportedly is not satisfied with certain phases of the program, and wants to take a different approach to speed its development.

According to DOD, *Dyna-Soar* "is being managed jointly by the Air Force and the National Advisory Committee for Aeronautics." If McElroy puts ARPA into the program, the decision on "who's in charge of what," probably will have to be made by the President.

• **Mating GAR-9 and Eagle**—Missiles Director Holaday brought out that the Navy's *Eagle* and the Air Force's *GAR-9*, both air-to-air missiles, "will be worked into one system." Development work on *Eagle* with its "all-weather capability," is being completed, Holaday said. About *Rascal*, Holaday pointed out that "it has been definitely limited in production because the state of the art has passed up the missile."

• **Three-stage** *Minuteman*—Holaday day confirmed publicly for the first time that *Minuteman* will have three stages. Touching on the *Bomarc* and *Hercules* controversy, he said neither program will be cancelled out. Both will be deployed to provide a "defense in depth."

When queried on whether he might become the new Defense Department director of research and engineering, Holaday said "it will not be me. I've got enough to do in my present job." The appointment appears days away.

Holaday said the U.S. has originated 74 guided missile projects but 34 were cancelled for technical difficulties. Before fiscal year 1958, he said, some $16.5 billion was spent on missile research, development and procurement. The U.S. will spend $6.7 billion in the same areas during fiscal year 1959.

m/r personal profile

Adm. Clark: He Bosses U.S. Space Projects

ARPA's top military man is a kid-gloved ramrod who gets things done by "more patience, less horsepower."

by Erica Cromley

While today's headlines spotlight the lunar-bent rockets of Cape Canaveral, tomorrow's are in the works in a suite of offices on the third floor of the Pentagon. Here, a team of 30 scientists sifts through the space proposals that have been pouring in from industry and the universities, separates the impossible from the feasible, recommends the practicable and draws up ways and means for those projects that are finally selected.

Organization of the high-voltage brainpower in the Advanced Research Projects Agency into a productive team was considered a tall order. But although ARPA has been in business only a few months, the wheels are humming over a well-prepared foundation.

Responsibility for ARPA's performance falls to its top man, industrialist Roy W. Johnson. But the man largely credited with the team's efficient operation as a unit is the agency's deputy director, Rear Admiral John E. Clark.

• **Responsibilities**—This short, wiry dynamo plays a major role in overall planning, sees that the boss's orders are carried out, makes all but the top-rung decisions and evaluates industrial space proposals. His job has been likened to that of an executive vice president; ARPA's role to that of a corporation division which has available the services of other divisions.

ARPA is the only office of the Defense Department with its own budget; it has authority to execute contracts and to deal directly with the service units without having to tangle with chains-of-command red tape.

Clark's background as an effective administrator and his familiarity with space problems as the Navy's missile boss combined to earn him the nod as ARPA's top military man.

However, another factor, probably of equal importance, is that Admiral Clark has a reputation as a successful salesman. This can be a powerful asset to a new agency that has to prove itself and that deals with a subject which is still to be sold to the public. In this respect, he has scored on three fronts: he makes a good impression with Congress, he is respected by industry and he is an effective public speaker.

Clark's one regret in his new and demanding job is that he must limit his speechmaking to one or two a month; he feels the public has a long way to go in education for the space age. ARPA gets many requests for speakers; but is able to fill only about 10%.

Cornerstone of Clark's effectiveness is his ability to fire enthusiasm over a new idea, then to organize the spreading conflagration into productive channels. Although the self-taught military space expert credits "being in the right place at the right time" with his first-stage launching onto the space scene, this is obviously not the main factor in his career.

• **Background**—The Admiral's experience in research and development began with aircraft and aircraft gunnery. In 1937-38 he was in charge of designing and manufacturing arresting gear at the Naval Aircraft Factory, Philadelphia. Several medals and assorted assignments later, when the Navy started taking a closer look at the coming missile age, the admiral was tapped to head the Air Objectives Section of the Guided Missile Division.

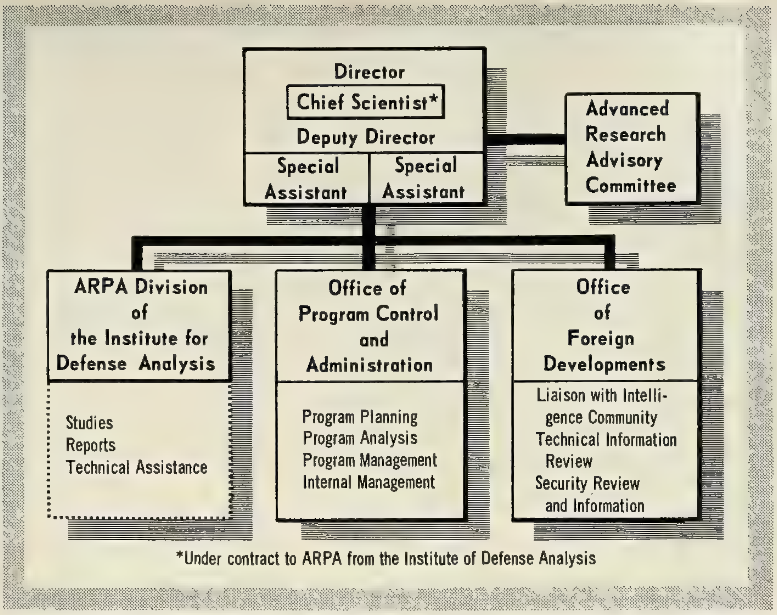
Said Clark, "I was captain of a ship which had just completed a mission to the South Pole when my orders came. I had no missile background. I just learned as I went along from people, books and visiting around.

"Few people realize what thin ice the country was on when the national missile program was started," Clark pointed out. "It was well understood that there was no solid foundation for design of the guided missile of the future. I don't think there was ever another time in history that man had embarked on such a vast project—a multi-billion dollar program—with so little to base his efforts on. It was as though the engineers of 50 years ago had decided to build a DC-7 immediately after Kitty Hawk."

Although Clark had had a brushing acquaintance with rockets during some earlier research work, both he and the Navy were starting pretty much from scratch. The Navy's Missile Division was drawing up requirements which were written around the state of the art at the time. It was a case of the chicken before the egg. Although crude rockets had been developed by BuAer and BuOrd, refinements were clearly necessary.

Under Clark's direction at AOS, and later as director of the Guided Missile Division, these refinements evolved, and led to such operational weapons as the Navy's *Terrier, Sparrow,* and *Regulus.*

While the country reeled from the


Director
Chief Scientist*
Deputy Director
Special Assistant
Special Assistant
Advanced Research Advisory Committee
ARPA Division of the Institute for Defense Analysis
Studies
Reports
Technical Assistance
Office of Program Control and Administration
Program Planning
Program Analysis
Program Management
Internal Management
Office of Foreign Developments
Liaison with Intelligence Community
Technical Information Review
Security Review and Information
*Under contract to ARPA from the Institute of Defense Analysis

ORGANIZATION CHART of the Defense Department's Advanced Research Projects Agency. ARPA is under the Office of the Secretary of Defense.

Sputnik-induced shock last October, Clark moved on a project he had been thinking about for a long time: He presented his plan for a space agency to the Armed Forces Policy Council.

Others had had the same thought and the ARPA organization evolved as a similar but modified version of the Clark plan. This proposed a joint Army-Navy-Air Force research unit on the grounds that "space is too big for any one service." The basic idea was bought, although as it is set up now, ARPA is an independent agency under the Office of the Secretary of Defense and is not directly related to the services.

• **Credits**—Although Clark is matter of fact about his do-it-yourself missile background, and credits much of his success to his availability, long-time Naval associates add a few factors. Here are some quotes:

—"He really worked to get into the job he has today. When he saw the missile program starting up, he took jobs where he could learn about it. He was one of the first in the Navy to feel the missile had a future."

—"Don't underestimate this man. He's a doer but he's also a deep thinker. He's well rounded out, and has a good grasp of the world situation."

—"Clark has always been interested in new things, pushing them. He was always fast to grasp new ideas."

—"He is essentially a planner who likes to look at all angles of a problem. But when he comes to a decision, he leads a very fast pace."

Those who work under him like his policy of exercising indirect authority without immediate supervision or command. He allows you to use your own initiative."

As ARPA's top military man, Clark keeps Johnson apprised of the military-requirements point of view. One Pentagonite pointed out that the civilian space chief "relies a great deal" on his military deputy.

Johnson quickly admits his high opinion of Clark, both professionally and personally. "He has the kind of personality you can work well with. We have a good team and he works well with them."

• **An appraisal**—While his associates are warmly articulate over the kind of job Clark is doing, he is equally vocal about his enthusiasm for the job. "It's intensely interesting. Not only because of the technological end of it, but because of the administration and organizational factors involved. This is a new idea and it presents a challenge.

"The big problem in this country," he added, "is not one of finding talent. We have the scientists, engineers, the know-how. The big problem is organizing it. We need better evaluation. Here at ARPA we've been extremely careful in picking our people—good people."

The scientific staff is hired by the Institute for Defense Analysis, a non-profit organization sponsored and directed by six universities, and then contracted to the research agency. This has several advantages including the bypassing of the regular involved U.S. employment procedures.

ARPA's main areas of activity are general advance space research, ballistic missile defense, and propellant chemistry.

Adm. Clark stresses that the agency likes multiple approaches on basic research and component work. "Wasteful duplication comes when too many final systems are supported." ARPA's Big Two try to see personally as many industry representatives who bear space proposals as possible. If they make their point, and their plans are feasible, a presentation is arranged before the evaluation staff.

Approved projects are contracted through military contracting agencies because though ARPA has power to sign contracts, it is more efficient to use the existing machinery.

• **A long day**—Getting the new agency into its growing orbit is no snap assignment. Most of the ARPA crew's working day covers a 10-hour span—from 8 a.m. to 6 p.m.

Clark was broken into the long-workday habit early. He began working on a farm 16 hours a day during the summer when he was 14.

The admiral describes his childhood as "a normal, small-town type life." An only child whose parents were separated when he was seven, he turned to his grandfather for guidance. The old man's tales of the military histories of countries set young Clark's sights on a West Point career. But Leavenworth is an Army post town and there were many other teenagers with the same idea. When John Clark had finished high school (he had already completed the first year of college math before graduation), the military academy quota from his area was filled and he joined the Navy.

Although his whole life is space-oriented right now, Clark looks forward to his return to the seas. "There is no thrill like having command of a ship." ARPA has him for one-year and then he expects to be reassigned to ship command for a couple of years. "After that I'll probably be back here for another bout with the Pentagon."

• **Patience and fortitude**—A man with long experience in how to get things done rapidly within the Defense Department structure, Clark has been teemed by one associate "a ramrod with kid gloves." Clark smiles at this and comments, "In the whirlwind time we live in, particularly in Washington, the lasting things are accomplished by patience and insinuation and not by horsepower."★

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Symposium Points To Lag In Telemetry Systems

Telemetering Session Places Blame For Slow Progress On Military and Prime Contractors; Urges Need for Attention To Components

MIAMI BEACH—The U.S. is definitely behind in the systems development aspect of telemetry. This was the general feeling of registrants at the National Symposium of Telemetering held here from September 22nd to 24th. Of a total of 75 technical papers given during the three day meeting, only a few touched on the systems concept and most of the more than 50 exhibitors featured individual components rather than completely engineered systems.

Participants of the symposium queried here felt that the lack of progress in the systems area is the fault of the military and prime contractors, especially in the missile field.

One scientist put it this way, "Today we have no choice but to leave it to other people to bring together components and make a system out of them. There are many individuals and companies in the telemetry field capable of developing systems, but as long as the military and the primes cannot make up their minds about what they want, there is nothing the telemetry manufacturer can do. We cannot afford to invest our money and talent unless we know that someone will buy the product."

• **Common Problem**—This remark pointed to a situation that is not unique in telemetry.

Any product which is produced predominately by small companies is prone to this same sort of thing. The company is not large enough to support a basic or applied research program, and the military or the primes are loath to support research with cost-plus contracts with a completed system as the end product. Their reluctance is not too hard to understand when it is probable that the systems developed will then go to other customers at off-the-shelf prices. However, this is a problem that has faced other industries before and has been solved, so it appears that, until some of the larger telemetry outfits are ready to support research programs on their own, they will have to live with the situation.

Including the general recognition of this problem, the conference was an unqualified success. More than 1,000 of the country's leading engineers and scientists in telemetry attended. The high quality of the technical papers delivered during the meeting as well as the excellent manner in which all arrangements were handled made the meeting a good one—in marked contrast to the telemetering conference held in Baltimore last June.

• **Radio Techniques**—More than half of the 75 papers delivered dealt with various telemetry problems of the missile and space age.

Leang P. Yeh of Westinghouse Electric delivered a paper on "Radio Techniques as Applied to Space Technology" which dealt with the general aspects rather than the specifics of telemetry in outer space.

Mr. Yeh discussed radio techniques which are considered applicable to space communications, the exploration of space by radio, feasible space communications systems and the utilization of bodies in space such as the moon, satellites and others for radio relay purpoes.

Most of the information presented was not new, but Mr. Yeh's survey of the general situation was well received by attendees. He concluded by outlining the future work required in space communications, and said, "At the present state of the art, it seems that the range of space communications is limited by the mechanical end of the problem such as putting larger vehicles in space so that more powerful transmitters and more elaborate antenna systems could be used."

• **R&D big factor**—Other discussion at the symposium concerned the fact that there is still much R&D to be done from the electrical end in telemetry, both in the communications and the power area.

Some of the real problems that face telemetry engineers today are: the development of high power transmitters with lower input power requirements; systems-engineered antenna systems for more overall gain through more efficient use or by time-sharing; reduction of the ambient temperature of antennas in space; reductions in bandwidth and improvements in modulation techniques; reduction of interference and noise in general; and improvement in power supplies, either through more efficient use of batteries or the development of other power sources such as radioactive isotopes or solar radiation.

It was generally agreed by participants at the symposium that, although much R&D is still required, the day when the moon or man-made satellites are used as passive reflectors for earth-to-earth communications is not too far away. Another general area of agreement was that communications between space vehicles would be limited to short range at present.

For long ranges, it is felt that we will have to wait for more transmitted power and antenna gain in space vehicles, or for the development of radically new techniques and mediums other than those known at the present time.

The symposium was followed on the 25th by a one-day classified session sponsored by the Air Research and Development Command at the Air Force Missile Test Center at Patrick Air Force Base.

DOFL Open House Marks 5th Anniversary

WASHINGTON, September 27th—Diamond Ordnance Fuze Laboratories, a Research and Development organization arm of U.S. Army Ordnance, celebrated its 5th year of operation with a limited open house for employees and invited guests today. Featured speaker was Major General John Hinrichs, Chief of Ordnance.

The outdoor exhibit, had an Army *Nike-Ajax* missile and an Army Missile Master System.

Exhibits in the laboratories applicable to the missile field included samples of the microminiaturization techniques developed by DOFL, short-pulse radar, an offshoot of proximity work done by the laboratories and non-classified fuzing and arming devices which are DOFL's specialty.

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Q. Are the guaranteed heat-treat alloys new?

A. The alloys are not. They have a production history of four years and a wealth of technical data to support them. Recent development of their full heat-treat capabilities has produced such dramatic results that they are considered new.

Q. What are the heat-treat alloys?

A. Ti-155A (5.5% aluminum; 1.5% iron; 1.5% chromium; 1.1% molybdenum) the highest strength bar and forging stock commercially available; and Ti-6A1-4V (6% aluminum; 4% vanadium), which in the annealed condition has already won wide designer confidence. Samples of *guaranteed* minimum heat-treat capabilities show:

	Ti-155A	Ti-6Al-4V
Section size: Up to 1"		
Ultimate Tensile Strength (psi)	170,000	160,000
0.2% Yield Strength (psi)	155,000	150,000
Elongation, % in 4D (Long)	10	10
(Trans)	8	8
Reduction in Area, % (Long)	20	25
(Trans)	15	20

Detailed information on Ti-155A is presented in a 20-page TMCA Engineering Bulletin. Additional data on Ti-6A1-4V, such as fatigue characteristics and guaranteed heat-treat capability are also available.

Q. Are there other new alloys?

A. The leading alloys nearing commercial volume are Ti-8A1-1Mo-1V, a bar stock offering excellent elevated-temperature creep strength to 1000°F, and Ti-4A1-3Mo-1V. The latter, now being produced and evaluated by the Department of Defense sheet rolling program, is designed to fill the need for high strength sheet alloy which can be formed in solution-treated condition and aged to strengths of 175,000 psi. When compared to other high-strength titanium alloys, Ti-4Al-3Mo-1V combines improved formability with outstanding elevated-temperature strength and stability.

Typical Properties — Ti-4Al-3Mo-1V

Condition	Temp. °F	0.2% YS psi	TS psi	Elong. % in 2"
Solution treated	Room	94,000	135,000	14
Solution treated and aged	Room	163,000	175,000	5
	200	142,000	169,000	8
	400	126,000	152,000	8
	600	111,000	140,000	7
	800	98,000	127,000	9

Q. How will these alloys raise temperature limits?

A. Ti-8Al-1Mo-1V is a good example. Although its short-time elevated temperature tensile properties are similar to Ti-6A1-4V, this new alloy offers as much as a tenfold increase in creep strength between 600°F and 1000°F, as shown:

Creep Comparison Between Ti-8Al-1Mo-1V and Ti-6Al-4V

Alloy	Annealing Treatment	Temp (°F)	Stress (psi)	Time (Hrs.)	Def. (%)
Ti-8Al-1Mo-1V	1400°F (24 hrs) AC	850	50,000	300	0.42
Ti-6Al-4V	1300°F (2 hrs) AC	850	50,000	300	3.6
Ti-8Al-1Mo-1V	1400°F (24 hrs) AC	950	15,000	300	0.16
Ti-6Al-4V	1300°F (2 hrs) AC	950	15,000	300	4.3

Now being evaluated by engine manufacturers, Ti-8A1-1Mo-1V appears to answer the need for light-weight strength at steadily higher temperatures. Data on both Ti-4A1-3Mo-1V and Ti-8A1-1Mo-1V alloy are available from TMCA.

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NAME TITLE

ADDRESS

CITY ZONE STATE

ISA Fears Technician Shortage

Educator's workshop at Instrument Society meeting stresses need for qualified semi-professionals

The future shortage of technicians is seen as one of the most serious problems for missile development by educators in workshop sessions at the recent Instrument Society of America Conference.

Pacing the weeklong program of clinics, professional meetings and lectures in Convention Hall in Philadelphia was the Educator's Workshop, moderated by Lloyd E. Slater, executive secretary of the Foundation for Instrumentation Education and Research. Educators attempted to analyze problems concerned with recognizing, defining and producing qualified engineering semi-professionals.

Participants agreed on one point: the technician problem is one of the lesser-known but most pressing needs in missiles today. Industry is not even quite sure of the definition of technician—at least from an educational and qualification standpoint. Even though the fad today is to decry the lack of basic science education as a prerequisite for advanced science studies, the devices that scientists and engineers develop are often failures in actual use because of improperly qualified semi-professional personnel at the launch site.

• Key men—According to Mr. Slater, the U.S. is faced with a dangerous shortage of properly trained technicians to install, test and maintain its burgeoning systems of instrumentation.

Pointing to several highly publicized mechanical failures in recent missile and rocket launchings, Slater said that, rather than a failure in rocket design, there was probably a shortage of properly trained personnel to service and put the birds in good working order.

"Whether or not this is true, it is a fact that some day all of the missiles, however big or small, now in development and test, must be operated by people other than scientists and engineers," Slater said.

"The problem of inadequately-trained military personnel is not too serious because of the prevailing trend to station contractor technical representatives at various installations, but the contractor himself must find his tech reps and how to determine if they are qualified or at least possible to train.

"With more and more missiles moving into the production and operational phases, it will not be too long before we feel the acute shortage of people capable of performing the less-than-scientific but more-than-ordinary technical duties."

Some of the solutions discussed at the workshop were: expansion of post-high school technical training; more applied approaches by vocational high schools; summer training courses in instrumentation for technician-training teachers; and the aid available from technical society-supported foundations such as FIER.

Panelists included: Dr. Karl O. Werwath, president of the Milwaukee School of Engineering; Thomas J. Rhodes, manager of the Process Development Department of the U.S. Rubber Institute; Abner G. Hathaway of United Electronics Laboratories; Dr. Kenneth L. Holderman, asst. dean of engineering, Penn State; W. H. Furry, director of training, The Foxboro Company; Burr D. Coe, director of Vocational and Technical High Schools, Middlesex County; Dr. John A. Hrones, vice president of Academic Affairs, Case Institute of Technology; and Herbert S. Kindler, director of Technical and Education Services, Instrument of America.

• 30,000 attend—The Conference and Exhibit attracted more than 400 exhibitors and over 30,000 registrants. The exhibit alone included more than $500 million worth of scientific instruments displayed in an area of around 200,000 sq. ft.

Four other societies cooperated with ISA on the technical program: American Society of Mechanical Engineers, American Institute of Electrical Engineers, Association for Computing Machinery, and Institute of Radio Engineers. Besides the more than 90 technical papers presented, other workshops included Sales Engineering, Control Systems, Maintenance Management and Data Handling.

The conference was not without a trace of international flavor. Three USSR scientists, Aleksandr B. Chelyustkin, Borris N. Naumav, and Aleksandr M. Petrovskiy, were scheduled to report on their individual activities in instrumentation and automatic control. However, they were late in arriving and their part in the program was cancelled.

Another Soviet scientist, Prof. Aleksandr M. Letov, associate director of the USSR Institute of Automatics and Telemechanics, and vice president of the International Federation of Automatic Control, was scheduled to appear at the keynote session, but late arrival also prevented his participation.

WILLIAM G. BROMBACHER has been chosen as an Honorary Member in ISA for contributions in instrumentation.

Speakers at the keynote session were Dr. Norman Cousins, editor of the Saturday Review, and Dr. Gaylord P. Harnwell, president of the University of Pennsylvania.

Next years conference and exhibit will be held between September 21 and 25 in Chicago.

• Officers and awards—Henry O. Frost, assistant chief engineer with Corn Products Refining Co., Chicago, was named president of the Society. Major honors for this year went to William G. Brombacher, former chief of the Aeronautic and Mechanical Instruments Section of the National Bureau of Standards, who was elected to honorary membership in ISA. His citation read: "For distinguished technical contributions to the field of instrumentation, in fundamental and pioneering studies of instruments . . . for service to his country, to science and industry."

During his career with NBS, Dr. Brombacher made many contributions to the government's research program in mechanical instruments. His major interest was refining and developing more accurate standards of pressure and humidity and related physical quantities. Under his direction, NBS extended the range of precise pressure measurements up to 200,000 psi and down to 0.00001 psi.

Electric Servos Aid Solid Fuel Storage?

Long-time storage, with no loss in performance, claimed for new types of heavy duty servos, may be a solution for upcoming second-generation "birds"

by Raymond M. Nolan

With more and more missiles moving over into the second generation, problems of long-time storage are becoming the foremost challenge to designers.

One serious area is that of servo mechanisms. Since World War II, the United States has relied almost exclusively upon the use of hydraulic actuation for high performance servo systems of large output torque and wide servo band pass.

The very success of this effort has focused attention on the phase which is iminent now—the development of servos which can stand a long storage period and yet be ready for instant use. Progress in this area has been less marked.

The development of efficient servo systems has made them dependent on the viscosity of the fluid used. However, in long term storage all known fluids either cause corrosion of the container or are prone to sludging (the development of different densities and viscosities due to slow chemical breakdown of the fluid.)

In fact, some reports indicate a distressing tendency to chemical deterioration of O-ring seals during extended periods of inactive storage under normal operating hydraulic pressure.

• **Solution offered**—One solution to the problem is by the use of electric servo systems. Electric servos are in use today, but only in applications requiring either low output torque or low output response. One notable exception is the *Redstone* missile which uses a set of relay-controlled high-power electric servos for both the booster fins and the warhead fins.

The Germans made considerable progress during World War II with electric servos, but almost all were relay-controlled. The success of their program was linked to the development of a special DC servo motor capable of providing both the large output torque and wide servo band pass necessary for their requirements.

Meanwhile, Advanced Research Associates Inc. of Kensington, Maryland, has developed a high-performance servo which overcomes the relay problem. In addition, this unit develops its thrust linearly, so that some of the shortcomings of units which convert rotary motion to linear thrust, such as excessive side loading, are eliminated.

The ARA Model 1350 Servo was developed as a small, accurate power amplifying device in the range of 50 to 800 lbs. thrust for actuating drone and missile control surfaces by providing a linear thrust displacement output precisely related to a low voltage DC input.

• **Construction**—The center mount block is 2½ inches square with 2 inch diameter tubing extending from each end of the mounting block with 9½ inches between mounting centers in its retracted position. The unit consists of an electric motor and gear box with a transistorized power amplifier.

Power is transmitted from the motor to the actuator rod end by a gearbox and a ball bearing jack screw. The standard motor and gear ratio provides a stalled thrust of 150 lbs. and a free running speed of 5.6 inches per second with a maximum power output of 24 watts.

However, several types of motors and gear heads can be accommodated in the aft housing to provide displacement thrusts up to 800 lbs. and free running speeds up to 20 in. per sec.

The servo system is designed to respond to current signals. The input signal is derived from a potentiometer connected with a current source, approximated by using a voltage source in series with a fixed resistor which is connected between the potentiometer wiper and one end of the pot.

The input signal is drawn as a current from the ends of the pot into an amplifier, whose input impedance is much less than the impedance of the pot. This means that, with the wiper at the extreme end of the pot, almost all of the source current will flow through the amplifier but with the wiper at the bottom end, no flow.

The advantage of this system is that it is ideally suited to the use of a transistor first stage, so the ARA system features a totally transistorized amplifier and requires no auxiliary power supplies other than those required to operate the motor.

The use of a low (100 to 1000 ohms) resistance potentiometer and the absence of vaccum tubes keeps leakage problems down and increases the reliability of the system considerably.

• **Servo power**—The motor used in the present servo is a standard Globe or Barber-Coleman, depending on customer specification and the gearing and ball bearing screw are off-the-shelf items easily obtainable.

Although the Model 1350 servo competes very well with comparable hydraulic servos, Norman V. Walker, president of ARA, sees a greater potential for high power in electric servos. Units developing power on the order of one hp have been the subject of considerable study and are now operating satisfactorily in the ARA lab.

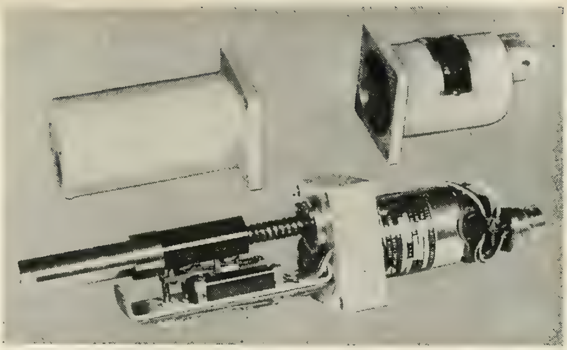
While most of the circuitry is merely scaled up from the present system, the motor has considerably improved performance and a different input arrangement is planned.

The few high-power electric servos studied by ARA are relay controlled and use an arrangement which accepts a few milliampere magnetic amplifier differential input and amplifies this input by the use of relays to about 200 amperes. The make and break contacts on the output relay carrying 200 amperes and the difficulty of adjustment with the driver relay presents problems which Walker says could be more easily solved by the use of high power switching transistors.

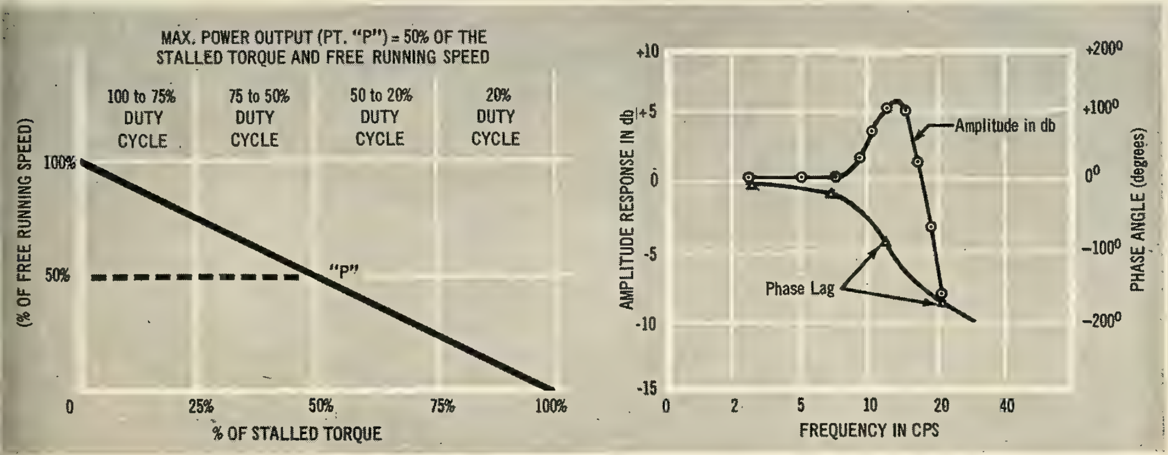
Transistors are now available to handle up to 50 amperes in the switching mode, but current flow when the circuit is nominally open makes the use of these units questionable due to the problem of thermal runaway caused by heating from the leakage current.

ARA proposes to solve this problem with transistor elements tempera-

COMPLETE servo sub-system with plug-in transistor amplifier.



ELECTRIC SERVO, front and rear covers removed from unit.



TYPICAL DUTY CYCLE and free running speed vs. stalled torque plot. (Left). Frequency response characteristics (right).

ture-stabilized with semi-conductors. Each element would handle 30 to 40 amperes and a bank of six parallel elements would provide the 200 amps needed for high power servo.

In front of the power section, Walker would use an ARA Type 9 transistor amplifier which is capable of converting an input signal of three milliamperes to an output of two amperes at 14 volts. The amplifier includes shaping networks to provide damping signals generated by the back EMF of the motor. It occupies a volume of less than three cubic inches and weighs about three ounces.

• Dudenhausen—The motor used in the servo is an American-produced unit modeled after the German "Dudenhausen" motor, an extremely rugged miniature device which was produced in Germany during WWII. The Dudenhausen was designed to provide very arge values of stall torque on an intermittent basis. The motor time constant was minimized by employing a elatively long armature of small diameter, together with a small air gap.

A series field was used, making the nit unsuitable for normal servo applications. The unit currently being used by Advanced Research Associates uses a strong permanent magnet field and achieves a threefold increase in total flux over the Dudenhausen motor.

Dimensions and performance data of the motor are 4.5 inches diameter by 4.5 inches long, time constant of 12 milliseconds, stall torque of 2 ft/lbs (intermittent), and no-load speed at 28 volts of 11,500 rpm.

Studies made by ARA show that a servo torque of 1500 in/lbs and an effective bandpass of 15 cycles per second are possible. The motor time constant of 12 milliseconds together with the small armature inductive lag provide a linear phase margin of about 35 degrees in the presence of servo loop gain required to provide a 15 cps bandpass.

Operating the motor at half voltage will give sufficient (1500 in/lb) torque with a gear ratio of about 170:1. This provides a maximum output shaft rate of 200 degrees per second. Sinusiodal output motions of over one degree may be obtained without limiting at a freqency of 15 cycles per second.

This, ARA believes, is adequate for actuation systems requiring between plus or minus 20 and 30 degrees for full control. By employing non-linear system design techniques, unusually small quiescent current drain can be obtained.

• Background—Advanced Research Associates, founded in 1957, concentrates on two lines principally—electric servos and advanced transistor circuitry. Walker's first contact with the servo problem was after WWII when, as head of Weapons Design Studies in the Royal Aircraft Establishment at Farnborough, he sifted through tons of material on the use of electric servos in German missiles.

His next assignment was as the Principal Scientific Officer of the British Joint Services Mission in Washington, where he had a first-hand opportunity to observe the servo situation in all of the U.S. missile programs.

This has led to his conviction that all missiles must eventually fall into two classes as far as servos are concerned—28-volt DC and "black box" hydraulic—the 28 volts being used on very small and very large missiles and packaged hydraulics used on medium-sized ones.

Gas Damping Extends Accelerometer Life

A new principle that is said to extend the usable temperature range of an accelerometer was displayed last week at the Instrument Society of America's exhibit in Philadelphia.

The Statham Model A501 accelerometer uses gas damping to permit accurate measurement of acceleration changes flat up to 500 cps. At temperature extremes (within the interval −65 degrees to +200 degrees F), the behavior of the A501 is approximately the same as that of a comparable oil damped accelerometer at room temperature. This extension of frequency response eliminates the need for heater jackets, making the new unit ideal for applications calling for small size accelerometers in variable temperature environments. Acceleration ranges available are for plus or minus 5 to plus or minus 50 g's, with ability to withstand accelerations up to three times the range of the instrument.

A paper describing the new principle was delivered at the ISA Conference by Dr. C. K. Stedman, research consultant to Statham Instruments.

Silicon Transistors For "Weather Eye" Satellite

All-diffused silicon semi-conductors that will allow higher power levels for transmitters, have been ordered by the U.S. Army Signal Research and Development Laboratories from Pacific Semiconductors, Inc., for use in transmission of cloud mapping data from satellites.

The transistors combine newly-developed characteristics which permit high power output at high frequencies under high temperature operating conditions. Expected to replace vacuum tubes in satellite instrumentation, the new units are to be used as oscillators to deliver three-quarters of a watt at 108 mc/s.

Use of the transistors, because of their lower power demands, will allow much longer transmission of intelligence from satellites. In some cases, germanium transistors are used now because of their superior performance at higher frequencies, but PSI claims that their product will equal high frequency performance of germanium without losing any of the high power performance of silicon.

The cloud mapping and storm tracking experiments are part of IGY scientific experiments. The experimental satellite will attempt to map the cloud cover of the earth and to locate and track major storms, such as hurricanes and typhoons, by telemetering pictures of the earth through a disc device similar to the Nipkov disc used in early television.

The spin of the satellite will serve as the line sweep for the image and the continuous advance of the satellite in its orbit will provide the advancement of the individual lines—possibly the world's first celestial TV. Photo-electric cells will convert the reflected light from the earth into electrical signals which will be recorded on a magnetic tape. The tape will then be played back and the information telemetered to earth.

Fusion Power Dominates October IRE Meeting

The critical role of electronics in the ultimate control of thermonuclear fusion for large-scale power production is one of the topics to be discussed at the two-day Electron Devices meeting to be held at the Shoreham Hotel, Washington, D.C. on October 30 and 31.

The session on fusion will be highlighted by the delivery of a paper, "Controlled Fusion" by E. W. Herold of RCA Laboratories, Princeton, N.J.

With almost all propulsion systems beyond the presently-used chemical ones utterly dependent on large amounts of electric power, one problem facing designers of ion and plasma engines is how to get this power. There is general agreement that the most promising method will be by controlled fusion, but the problems are so formidable at present that even with laboratory conditions, no practical control of fusion exists. In recent months however, the U.S., Russia and England have reported independently that they are achieving extremely high temperatures in experiments, a vital prerequisite for controlled fusion.

URSI and IRE Joint Meet To Feature Space Vehicles

USA National Committee, International Scientific Radio Union (URSI), and IRE's Professional Group on Antennas and Propagation, and Professional Group on Information Theory will co-sponsor a meeting at Pennsylvania State University, October 20-21.

The program, which includes discussions on such topics as: "Tropospheric Structure and Motions", "Beyond-The-Horizon Propagation", "Ionospheric Structure and Propagation", and "Scattered Signals", also features a symposium on "The Use Of Space Vehicles."

In the next few years, the rapid development of sounding rockets and satellites will open new research frontiers. The number of vehicles available for studies in radio science, and their capabilities, is growing rapidly. So that the greatest advantage may be taken of the new opportunities for space research, it is important that as many proposals for specific experiments as possible be brought forward and made generally known. The symposium is intended to assist in this function.

The panel will consist of experts in the field, all of whom have actively proposed experiments dependent upon the radio instrumentation of space vehicles.

July Transistor Sales Drop, EIA Reports

WASHINGTON—According to the latest figures from Electronic Industries Association, factory sales of transistors declined somewhat in July, from the June sales level.

However, the statistics of cumulative sales for the first seven months of 1958 shows a substantial increase over the high level recorded by EIA for the same period last year.

The July sales amounted to 2.632 million units worth $6.599 million. This compares with 3.558 million units and $8.232 million for the month of June, and 1.703 million units sold at a value of $4.216 million during July 1957.

The following chart, prepared by EIA, show factory sales and dollar value of transistors for the January-July period of 1958. The unit figures for the corresponding months in 1957 are included for comparison purposes.

	1958 Sales (units)	1958 Sales (dollars)	1957 Sales (units)
January	2,955,247	$ 6,704,383	1,436,000
February	3,106,708	6,806,562	1,785,300
March	2,976,843	6,795,427	1,904,000
April	2,856,234	7,025,547	1,774,000
May	2,999,198	7,250,824	2,055,000
June	3,558,094	8,232,343	2,245,000
July	2,631,894	6,598,762	1,703,000
TOTAL	21,084,218	$49,443,848	12,902,300

Glass-Fiber Launchers

British Firm Offers Units For Aircraft Use

Four types of rocket launchers made of glass fiber reinforced plastic have been developed by Microcell Ltd., of London and Camberley, England. They are: (1) Retractable 14-tube launcher mounted in the aircraft fuselage. (2) 20-four tube launcher that can be pylon-mounted under the aircraft wing. (3) 37-tube launcher pylon-mounted under the aircraft wing. (4) Retractable 24-tube launcher.

Advantages of glass fiber reinforced plastic for rocket launchers are based on a comparison with all-metal construction. Among the main advantages claimed by Microcell are:

(1) Materials of construction are readily available in the U.K.

(2) The material is non-strategic.

(3) The material is not reclaimable by an enemy in time of war.

(4) The labor used in manufacture, which in production is mainly unskilled and semi-skilled, is spread evenly throughout all stages, including material manufacture, small numbers only being used on launcher assembly.

(5) Good economy of manufacture can be achieved in production. Not only can cost saving be achieved by improved tooling, moulding techniques and assembly jigging, but also in the use of cheaper types of reinforcing glass, since the bulk of material used is of necessity not highly stressed.

(6) Storage for long periods and/or under extreme climatic conditions produces no chemical deterioration or corrosion.

(7) Complete absence of corrosion will reduce the amount of service maintenance.

(8) With production type tooling, no special finishing operations are required to produce a clean aerodynamic surface.

(9) The avoidance of thin sections, consequent on the use of a lower density material produces a more robust design for handling.

(10) The good basic impact resistance of the material also lessens the chances of damage due to shock loading.

(11) The lack of electrical conductivity of the material largely eliminates the possibility of an electrical short-circuit.

(12) The low thermal conductivity of the material ensures that the heat soakage from the rocket exhaust gases is not sufficient to burn away a significant amount of wall material, and also gives an appreciable time delay to the transmission of aerodynamic kinetic heat to the rocket cordite.

(13) The comparatively low value of Young's Modulus for the material will avoid high thermal stresses being set up.

Early LOXing Blamed For *Atlas* Failure

The unsuccessful flight of the first full-range shot of the *Atlas*-A, a great setback for the ICBM program, was apparently plagued by the outstanding bottleneck of the U.S. current missile program. Unofficial speculation and analysis of the failure blame the extended length of time the LOX was held in the missile's tanks while awaiting launch.

The *Atlas* was two hours and 26 minutes late getting off the stand, which meant that the liquid oxygen was in the tanks for over three hours. Prolonged LOX contact with the tanks and engine system initiates a multitude of flow problems and weakening of the metal parts.

The 80-second flight was only half of the burning time of the two booster engines. At about 160 seconds, the boosters would have dropped away, leaving the sustainer to propel the missile for another 2½ minutes.

This was the 13th flight of the *Atlas* and the third full-powered flight. This made the second failure since the three-engined *Atlas*-A started its flight program.

Equatorial Launch Site Hinted For Satellites

The establishment of an equatorial launch site for the first manned orbital space vehicles and space station assembly operations, was indicated by Cmdr. Robert Freitag, USN, director of planning and development for the Pacific Missile Range.

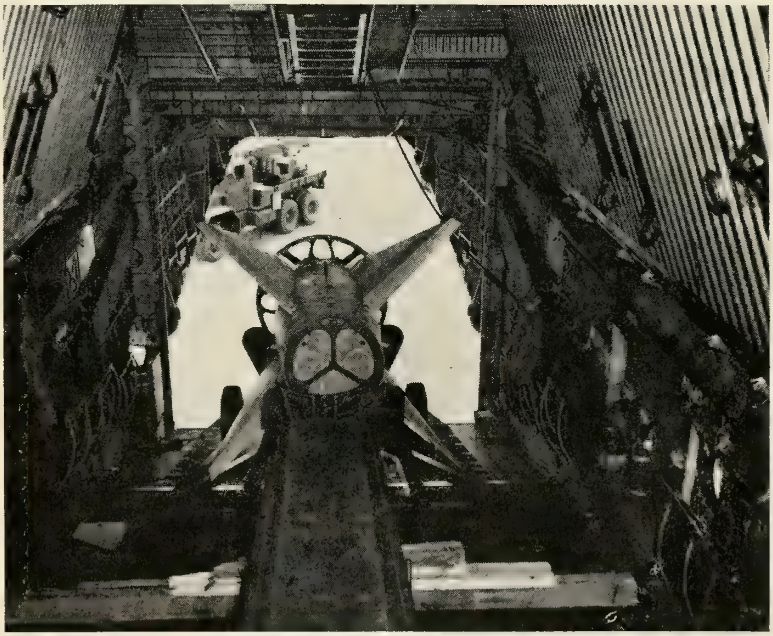
The Navy officer did not disclose any proposed location for such a site, but said that such a launching facility may be foreseen in the "not too distant future," if early steps in space exploration prove out.

Speaking before the Los Angeles section of the Institute of Radio Engineers, Freitag pointed out the advantages of an equatorial site would include a maximum utilization of the earth's rotational velocity. This would provide for a maximum payload for a given amount of fuel and allow a repetitive orbit.

"Once a satellite or a space vehicle is in orbit around the equator," said Cmdr. Freitag, "it will continually pass over the same series of stations without any regression of orbit incident to the shape of the earth."

This characteristic would minimize the number of tracking stations required for the satellite operation and permit maximum control, allowing recovery out of orbit or the joining of multiple vehicles in orbit.

Nike-Hercules Moves Fast



AIR TRANSPORT of *Nike-Hercules* missile is facilitated by handling ring on tail. Booster is shipped as a separate unit. Pacific orders have been issued for the first *Nike-Hercules* battalion. The 2nd Missile Battalion of the 71st Artillery Regiment, now stationed at Fort Bliss, has been assigned for duty to HQ US Army, Pacific.

Atomic Rocket Near Test Firing

Rover Expected to Back Proponents of Nuclear Power

by Alfred J. Zaehringer

The *Rover* Atomic Rocket is now nearing the test firing stage. If successful, it will back up AEC's contention that nuclear propulsion is the only real way of exploring space. Project *Rover* was undertaken by Los Alamos Scientific Laboratory on a fairly modest scale in 1955.

Work is spread over several of the laboratory's divisions, with most of the design work centered in N Division formed for this purpose. Leader of N Division is Raimer E. Schreiber with alternate leader R. W. Spence. LASL is working only on reactor-propulsion systems, not on the missiles or rockets they might propel aloft.

First tests of reactor systems at NTS (Nevada Test Site) are due late in 1958. Former Chairman Strauss has said that flight tests of rockets powered by nuclear systems are more distant than 2-3 years from now.

The atomic rocket engine, itself, will be tested in the "400 Area" at Jackass Flats. Under construction are three major building groups with supporting roads, water lines, smaller buildings, railway line, electrical power net, and a propellant tank farm.

• Buildings under construction—*Control building area*—This is the major structure. Floor area is 9700 square feet. Houses controls and instruments for operating and recording tests. Construction is of reinforced concrete.

Other smaller buildings are: generator power house (auxiliary power only), administration building, two warehouses, cafeteria, plus a guardhouse. Control building area facilities are being constructed by J. A. Tiberti Construction Co. of Las Vegas on a $815,572 contract.

Test Cell Area. The cell itself will be of reinforced concrete and have an area of 1,680 square feet. The atomic rocket (illus.) will be housed on a railway flat car which can be backed up into the cell. The test cell is about 1½ miles from the control building.

The railway-mounted rocket can be moved by a remotely controlled locomotive operating on a railway line leading to the assembly-disassembly building. Near the test cell is located a tank farm which will contain the bottles of gaseous working fluid-helium or hydrogen. The Petroleum Combustion & Engineering Co. of Los Angeles has a $1,209,000 contract for construction of the test cell and tank farm.

Mechanical assembly-disassembly building. The Sierra Construction Co. of Las Vegas is building this facility under a $2,058,355 contract. The massive building is of concrete with 30,000 square feet of floor area where the atomic rocket can be assembled before test or torn down after test. The facility, therefore, will have to handle such operations remotely since radioactivity will be involved. Nearby will be a small office, warehouse, and guard building.

It is expected that the *Pluto* atomic ramjet program will utilize some of these test facilities.

• Rocket Details—Preliminary details on the atomic rocket earlier published in m/r (Aug. 4, 1958, p, 27) have been verified by AEC. AEC says that an atomic pile will be used to heat up a working fluid which can be exhausted through a nozzle to form thrust. As a starter helium will be used (because of its uniform behavior and inertness). Later hydrogen will be used. The first phases of the program will use the gaseous elements. Later, liquids may be used.

The pile, nearly circular in plan, will be mounted on a railway flatcar. The pile is several feet in diameter. Total weight of the test pile is 5-6 tons. Since this is a test rig, no attempt was made to cut down excess weight. Control rods will be used to regulate the amount of heat within the pile. No temperature figures were given but yellow-white heats have been mentioned. This corresponds to temperatures of about 3,000°F.

Presently-operating reactors are experiencing low lives of fuel elements at about 2,000°F. Therefore, AEC feels that it will lose fuel materials out the nozzle. Energy yield of such losses will be low-on the order of a fraction of a kiloton. "Spew-out," AEC says, will be less than a low-yield military weapon.

In addition to the exhaust products, neutrons will be generated which will be caught by shielding. However, the entire cell is expected to be "hot" for some time after test.

• Thrust Low—Since gaseous propellants will be used, the operating time will be restricted. Since the pile will take several minutes to come up to full temperature, coolant will have to be added during this time. This will also decrease the total full thrust operating time. Operating thrust at full power level is anticipated to be considerably less than 5,000 pounds. As a matter of fact, first tests will not be with gas fluid.

It is estimated that it will take about 6 months or so to play around with control rods and ways and means of bringing the pile up to temperature. Then, tests will swing over to the hot gas phase. Fall apart would be a more appropriate expression in the event of an uncontrolled test than the conventional blow apart with chemical rockets.

Getting the reactor, reactor materials, and fuel elements to maintain structural integrity will be a task—a task that must be solved if atomic rockets are to break the barriers now hovering just above the heads of chemical rockets. NACA sees the top for solids at about 270-300 in I_{sp} and something like 350 with liquid fluorine combinations.

The first *Rover* rocket may not get this high, but eventual hopes are for at least 400-600 in specific impulse. Big factor—to be determined at Jackass Flats—is whether a *Rover* type rocket can generate a significantly higher thrust on the basis of entire system weight as a super chemical rocket.

Right now, the radiation and temperature problems make the present atomic rocket inferior to the chemical rocket on a thrust-to-weight ratio. Theoretically, it looks good. To get anywhere near theory—well, that's an engineering problem for AEC.

. . . Plasma Jet Thrust Up

(Continued from page 11)

gine of Plasmadyne's should not be discounted. It could conceivably be powered for long-time flights by solar batteries. Some example of its potential is that a ten-pound thrust engine operating for one month could increase the velocity of a ten-ton vehicle by approximately 25,000 mph.

Other companies active in the plasma jet field are General Electric, where the free world's largest stabilized jet is used for re-entry simulation. Avco Research uses the plasma jet for reentry simulation. Republic Aircraft recently announced that they had a magnetic pinch plasma engine in operation.

Probably the most comprehensive program in the country is being conducted by the Lewis Flight Propulsion Laboratory of NACA in Cleveland. Scientists there have been using plasma jets for high-temperature research for some time. These differ from those needed for propulsion in that their efflux is air, the gas needed for good aerodynamic heating simulation.

EIA Recommends Study Of Radio Spectrum

WASHINGTON—A government-established commission to make a long-range study of the entire radio spectrum and its administration has again been approved by the directors of the Electronics Industries Association. The action came at the conclusion of a three-day quarterly conference at the St. Francis Hotel, San Francisco, Sept. 16-18.

The Military Products Division of EIA, under chairman Sidney R. Curtis, received reports on military activities and announced two upcoming symposiums: A Military Procurement Practice Conference at the Statler Hotel in Washington, October 23. Assistant Secretary of the Army Frank H. Higgins will be the principal speaker.

Also scheduled, a symposium on the current activities of the Military services with regard to materiel support and related problems. This will be held at the Beverly Hilton Hotel in Los Angeles, October 24th.

Chairman Paul B. Wilson of the Prime-Sub-Supplier Relations Committee reported that the Small Business Administration had asked EIA to assist in the drafting of standard clauses for the protection of small manufacturers and sub-contractors. The committee also discussed plans for preparing a booklet of practical interpertations of governmental directives having to do with relations between prime and sub-contractors.

The Board of Directors approved a switch of the 1959 West Coast and New York meetings. The September Quarterly Conference will be held in New York, and the late November meeting will be held in Los Angeles.

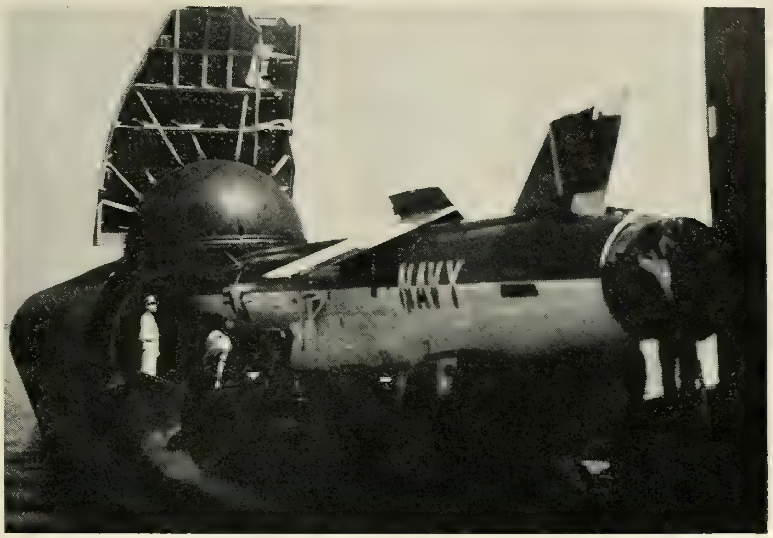
Rese Engineering Adds Digital Department

Rese Engineering Inc., Philadelphia, has formed a Digital Systems Engineering Department, and has elected new officers for the parent company. Rese manufactures a line of instruments ranging from power frequency flux-reset core testers to millimicro-second programmed current pulse generators.

The new department will provide complete services from consultation to systems assembly of special data-handling equipment such as magnetic core and drum memories, buffers, machine tool control and digital system simulation.

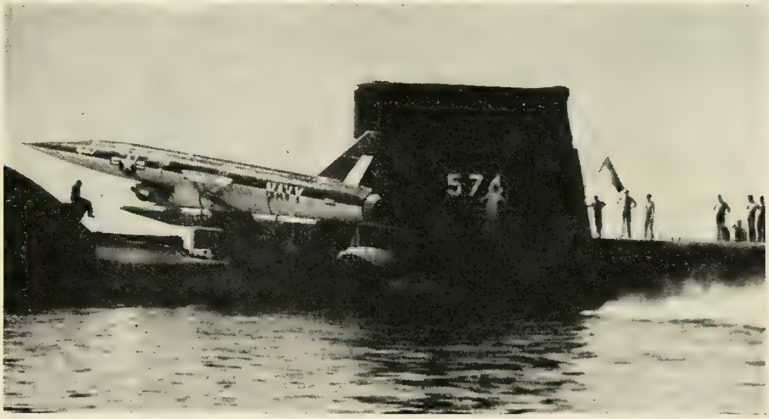
Former company president Jerome . Rovins was elected board chairman and secretary; Richard O. Endres, previously secretary-treasurer, was elected president; Lowell S. Bensky was appointed vice-president for the new department.

Regulus II Takes Off At Sea

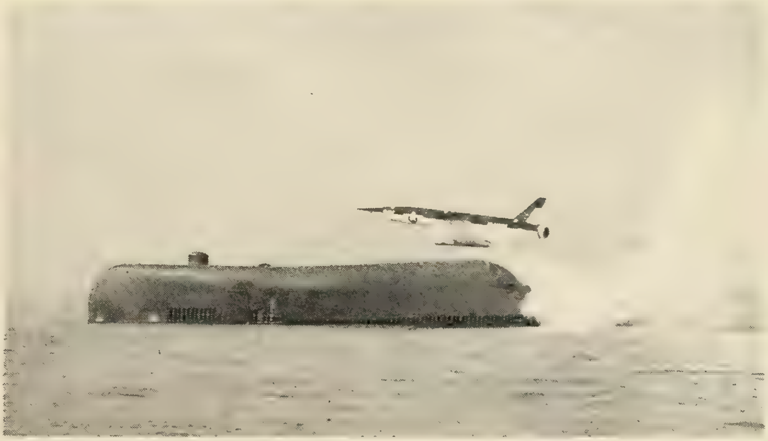


U.S. Navy

BACKED OUT OF ITS HANGAR on to deck of submarine Grayback, Chance-Vought Aircraft's *Regulus* II is readied for firing at a land target some 200 miles away.



AIMED AND READY to take off, supersonic missile gets final checkout. Wings and rudder can be folded to facilitate storage in submarine hangar.



UNDER FULL POWER of its Aeroject booster rocket, missile is on its way. Blast hides aft part of sub. A GE turbojet engine supplies thrust after booster drop-off.

The Mobile Missile Market

Like a mobile . . . the missile market is made up of separate parts and different elements. Many industries and thousands of companies compose the mobile missile market. Aircraft companies build missile frames and prime systems. Automobile companies manufacture missile systems . . . a cereal company builds missile subsystems.

And like a mobile . . . there is constant movement and change in the missile market. New developments happen fast. That's why missile men in management, engineering, production and procurement need an undiluted missile book to be posted constantly and accurately. Throughout the complex market missile men look to MISSILES AND ROCKETS as the number one missile book.

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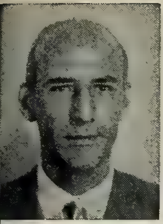

propulsion engineering

by Alfred J. Zaehringer

Rover atomic rocket will start out as a gaseous working fluid system. Helium will be first, then a switch to hydrogen will be made. Gas will be stored in bottles. Size of bottle farm will dictate thrust level and operating time. Entire static rig weighs 10-12,000 pounds and is nearly circular. Diameter is measured in feet. Big problem will come from loss of gaseous fuel elements migrating from pile, spewing out of the nozzle. Neutrons will also be emitted. Total yield of test *Rover* is a fraction of a kiloton. *Rover* with satellite or ICBM capabilities will be less than five kilotons energy equivalent.

The "ultimate" chemical system—fluorine and hydrazine—has been run in a small rocket engine. Maximum theoretical performance is 315 seconds. The Air Force figures that such a combination in a *Thor* or *Jupiter* could place a satellite around one of the planets. All seem to agree, however, that fluorine and hydrazine will be nasty to deal with operationally. Chemical "fallout" of toxic fluorine compounds may even dictate use of conventional chemical boosters for surface operations or exclusive use of fluorine in space.

Hydrazine decomposition flames are being investigated by the University of Leeds in England. Burning velocity appears to be independent of pressure and is about 46 in/sec. In small diameter tubes, hydrazine less than 88% concentration will not burn.

Powerful fuel, hydroxylamine, is being produced by Hungarian research teams. Yields of 90% or more have been attained in Raschig synthesis. USSR has been investigating the use of this and other nitrogen fuels. Many propellant applications have been predicted for NH_2OH. NACA, for example, calculates performance of 240 seconds in stoichiometric combination with LOX or 246 with LOZ. Having about the same molecular weight as hydrazine, hydroxylamine has a higher freezing and boiling point but is less toxic. Large-scale production in US may be near.

Nitrogen fuels and propellants are arousing great interest. England's Explosives Research and Development Establishment at Waltham Abbey has reported work on the combustion of 2, 3 and 1, 4 butanediol dinitrates and some aldehyde-nitrogen dioxide mixtures. Bell Aircraft is concerned with the detonatability of fuming nitric acid-heptane-nitrogen mixes. Hercules Powder Co., a big solid rocket firm, is getting into the liquid act by constructing a nitrogen tetroxide plant at Hercules, Calif. N_2O_5 is being pushed as a storable replacement for LOX.

Pre-packaged liquid rockets by Reaction Motors uses a hypergolic combination. This leads to the belief that nitric acid or a nitrogen oxide is to be used as the oxidizer plus an amine or hydrazine derivative for fuel. Maximum I_{sp} might be on the order of 225 seconds. RMI has a $1 million contract for application of the storable liquid in the *Guardian* air-to-air rocket.

Turbulent combustion studies are still underway. Japan, USA, and the USSR were among those reporting at the Sixth Symposium on Combustion held at Yale University. The Japanese concluded that turbulent combustion is a mixing process while NACA showed that the turbulent pressure exponent was about 0.3 greater than for laminar burning. Moscow research suggests that it is possible to decrease the total flame length by decreasing burner tube length or adding ignition sources.

British *Thunderbird* Fully Mobile Weapon

The English Electric Thunderbird SAM, adopted by both the British Army and the Royal Air Force, has been developed into a fully mobile weapon system comprising ground radar, launchers, fire control units and associated test equipment.

The *Thunderbird* is transported to its launching site on a mobile launcher-erector. The wheels on the launcher are easily detachable, enabling the launcher to be deployed on rough ground, making final adjustments with permanent levelling jacks.

The *Thunderbird* has been fully proven in tests at the Aberporth, Wales, and Woomera, Australia, ranges. Several hundred have been fired to date.

The bird used a two-stage propulsion system comprising wrap-around boosters and a sustainer motor. While in flight, the missile is steered to its target by control fins. A semi-active guidance system is used which is designed to operate with existing early-warning radar. Powered by a solid propellent rocket motor, the *Thunderbird* homes on radar pulses transmitted from the ground.

Dimensions of the *Thunderbird* are: length 21 ft. 10½ in.; wing span, 5 ft. 3 in.; control fin span, 5 ft. 3 in.; center section diameter, 1 ft. 9 in.; angle of wing sweepback 45 deg. Unofficial sources quote the following additional data: launching weight, 3,300 lbs.; max. speed, 4,000 ft. per second; range, 35 miles.

Missile Firm's $10 million Debenture Oversubscribed

Testifying to the strength of missile-oriented corporations in the eyes of the business community was the reported oversubscription last week of a $10 million 4⅞% subordinated debenture issue by Garrett Corp.

The offering, made Thursday, was quickly oversubscribed, and the books closed. Late in the same afternoon, it was reported, some Wall Street dealers were quoting the new debentures at 102¾ bid, and 103½ asked.

According to the terms of Garrett's offering, the new debentures are convertible—prior to Sept. 15, 1968, into common stock at the rate of one share for every $46 of face amount of the debenture. Proceeds of the sale will be used by the company in order to repay $9 million of short-term loans. The remainder will be used for expansion of facilities.

Garrett, with home offices in Los Angeles, Calif., is heavily involved in missiles through its AiResearch Companies.

missile people in the news

Top Brass

Frank H. Erdman has been named president of Kett Technical Center, Inc. research and development center of U.S. Industries, Inc. Erdman succeeds **Karl Schakel** as president of the U.S.I. operation, it has been announced.

Gerald T. Halpin is now vice president of Atlantic Research Corp., Alexandria, Va. He will also continue as the company's manager of operations.

Donald J. Guth was appointed comptroller of Solar Aircraft Co., San Diego, Calif. Guth was plant comptroller at the company's Des Moines, Iowa, facility.

Roy J. Benecchi has been elected senior vice-president of Lear, Inc.; **James L. Anast, James P. Brown, K. Robert Hahn** and **Joseph M. Walsh** were named vice-presidents.

Larry Blythe was elected treasurer of Beattie-Coleman, Inc., Blythe's appointment was the second new corporate election this month. **J. A. Wilcox,** sales manager, was appointed vice president. Blythe was an accountant, assistant to the controller, division controller, general manager of the West Coast Division, and assistant to the president for Standard Products Co. of Ohio. He joined Beattie-Coleman in 1956 as controller, and served as assistant secretary.

Fred Spiegel has been elected president of Titanium Fabricators Inc., Burbank, Calif. Spiegel, founder of the company and former executive vice president, replaces O. M. Bell, resigned. Other board actions included the reelection of **Dr. Morris Asimow,** professor of Engineering, UCLA, as vice president; and appointment of **N. Ray Johnson,** Los Angeles contracts consultant, to the Board.

Training

George A. Davies, senior instructor for Rocketdyne at the Ordnance Guided Missile School at Redstone Arsenal, has been transferred to California where he will supervise the *Atlas* training program for Rocketdyne.

James Jordan, chief of Rocketdyne's components modification and repair laboratory at Redstone Arsenal, will now be in charge of a similar CMA laboratory at the Air Force Missile Test Center, Florida.

Dr. W. F. Faragher has been appointed assistant to the president, Temple Univ. Research Institute. The Institute does extensive research in the fields of chemistry at high temperatures, propellants for missiles and specialized organic chemistry.

Sales

George A. Hagerty has been promoted to manager of the marketing section of the General Electric Computer Department. He has been manager of the product planning and marketing research subsection since joining GE in 1956.

Robert J. Muth, former Los Angeles branch sales manager for Exide Industrial Division of the Electric Storage Battery Co., has been transferred to the Philadelphia headquarters of his firm as field sales manager, a newly created position.

James G. Gelder was appointed marketing manager, electronics division, Diamond Power Specialty Corp. He will have responsibility for all sales, service and application engineering activities of the division, which manufactures Diamond Industrial Television and other electronic products. Gelder was formerly sales manager, Process Control Systems, for Philco Corp.'s Government and Industrial Division in Philadelphia.

J. W. "Jack" Swan has been named representative for the Chicago district, Parker Seal Co., division of Parker-Hannifin Corp. Swan's new duties include cooperative work with the Parker o-ring distributors.

F. W. Lloyd was elected to the position of manufacturing vice president of the Northrop Division, Northrop Aircraft, Inc. **Richard R. Nolan,** formerly in that post was elected corporate vice president and general manager of the division.

Charles Vickery has been named manager of the Los Angeles marketing office of the Defense Products Division, Fairchild Camera and Instrument Corp.

William L. Vaughan, veteran of 18 years in the purchasing field, has been appointed manager of purchasing at the San Diego plant of Solar Aircraft Co., succeeding **Russell L. Stevens,** the company announced.

W. V. Warner was appointed to the newly-created position of general sales manager of Ford Instrument Co. He was formerly manager of Air Force Contracts, and prior to this assignment functioned as head of the Ford Instrument Company's Mid-West Engineering Office in Dayton, Ohio.

Robert A. Marshall was appointed sales manager of Federal Electric Corp., Paramus, N.J., service organization of International Telephone & Telegraph Corp.

James K. Story has been named to fill the newly created post of sales manager of transducers and systems for Donner Scientific Co. Story was formerly an applications engineer in the transducer and inertial systems division of Donner.

Advertising correspondence should be addressed to Advertising Sales Manager, Missiles and Rockets, 17 East 48th Street, New York 17, N.Y.

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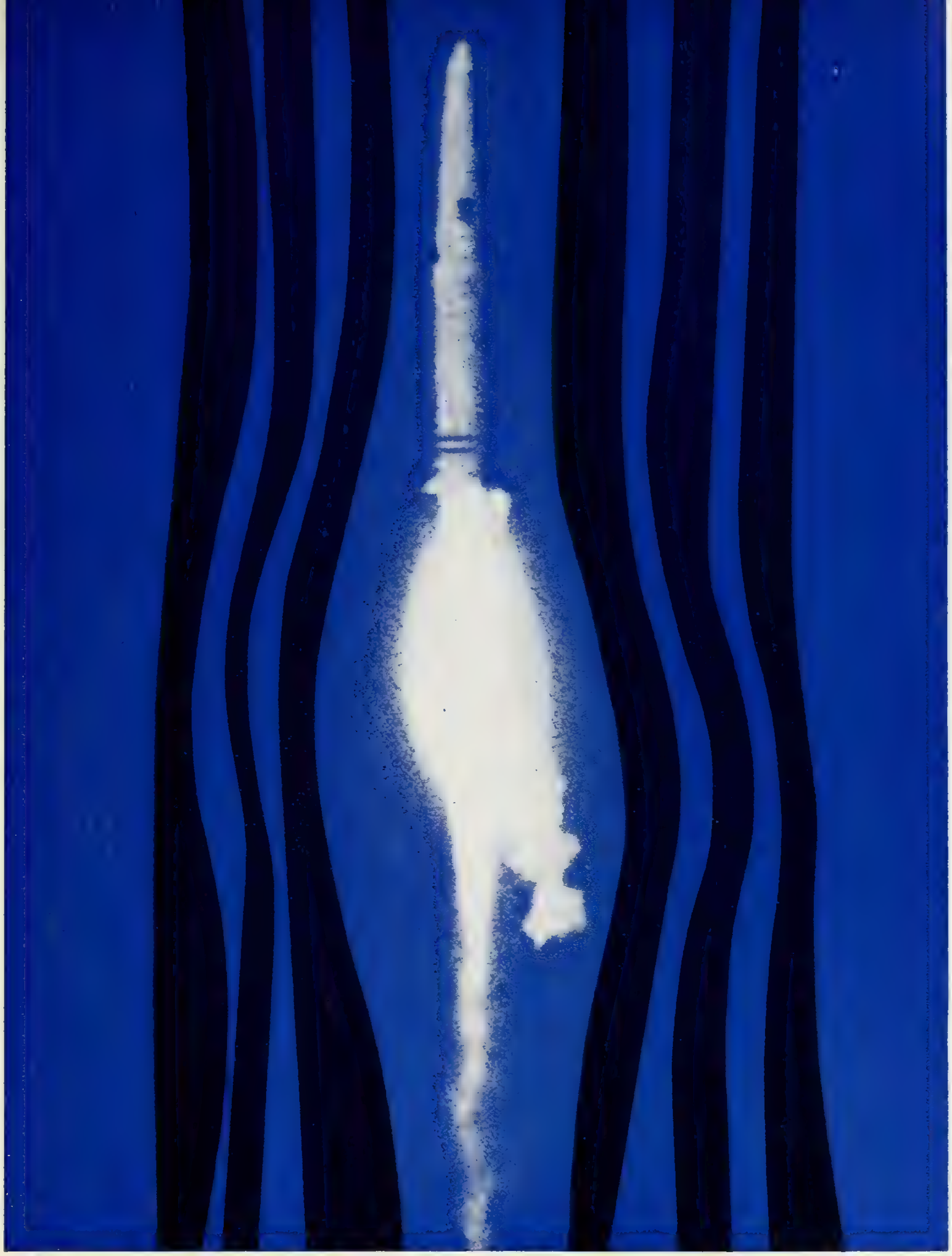
advertiser's index

Aerojet-General Corp., Sub.-General Tire & Rubber Co. . . 8
Aeronca Mfg. Corp. 3
Allegany Instrument Co., Inc. . . 17
Avco Mfg. Corp. 35
Diversey Engineering Co. 4
Hydro-Aire, Inc. 2
Janitrol Aircraft Div., Surface Combustion Corp. . . 6
Lukens Steel Co. 10
Thiokol Chemical Corp. 36
Titanium Metals Corp. of America 24
Wyman-Gordon Co. 22



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OCTOBER 6, 1958

X-15 Rollout Oct. 15

See p. 17

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MAGAZINE OF WORLD ASTRONAUTICS

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AN AMERICAN AVIATION PUBLICATION

VERSATILE, RELIABLE DIGITAL INSTRUMENTS

DC digital voltmeter offers maximum reliability... 0.01% accuracy... single-plane readout...and many other advanced features

The Model 401 offers four-digit display with automatic polarity indication and decimal placement . . . Measures .0001 to 999.9 volts with 0.01% ±1 digit accuracy . . . Adjustable least digit sensitivities of .1, 1, 10 mv . . . Average reading time of one second . . . Continuous, automatic standard cell calibration . . . 10 megohms input impedance . . . Built-in printer drive . . . 10 times longer readout bulb life . . . No circuitry in readout for easy remote mounting . . . Extra long relay life assured by DC drive. Price: $2100.

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Four ranges: 0.000 to 1.599; 00.00 to 15.99; 000.0 to 159.9; 0000. to 1000 volts (manual ranging and polarity) . . . No moving parts . . . Digital in-line readout . . . 70 millisecond conversion time . . . Adjustable display time . . . Input completely floating and isolated . . . 0.1% of full scale accuracy . . . Direct voltage conversion circuit . . . Wide range of models.

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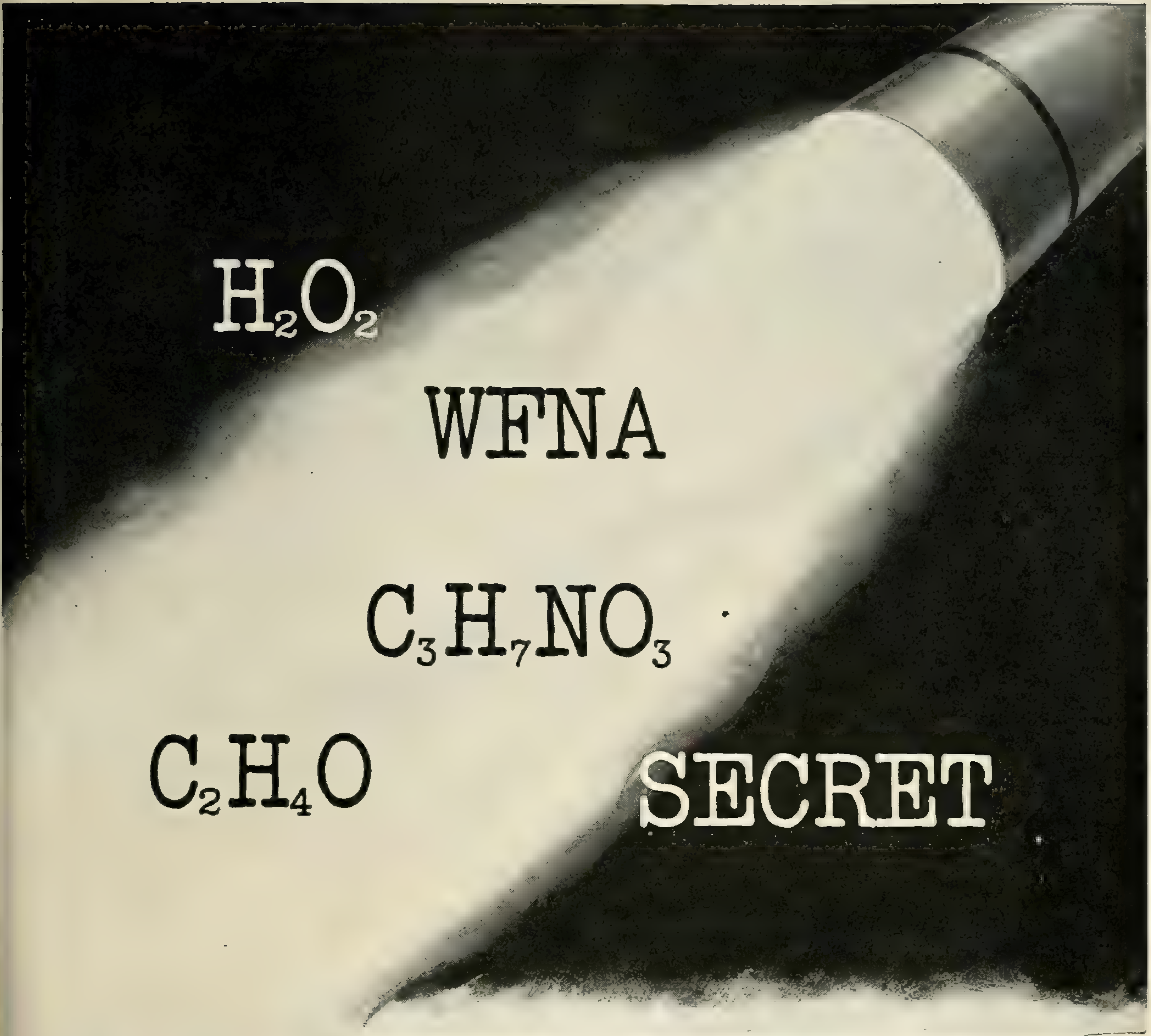

Who can handle **Fuel Cells for the Tough Ones?**

Many designers and builders faced with the problem of taming new and furious fuels to the task of powering tomorrow's planes and missiles *have discovered an ace in the hole:*

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Goodyear plants in Akron and Los Angeles have pioneered new materials and developed ingenious cells to cope with the temperature extremes, corrosive characteristics and other problems involved in the safe handling of today's monopropellants and fuel-and-oxidizer systems.

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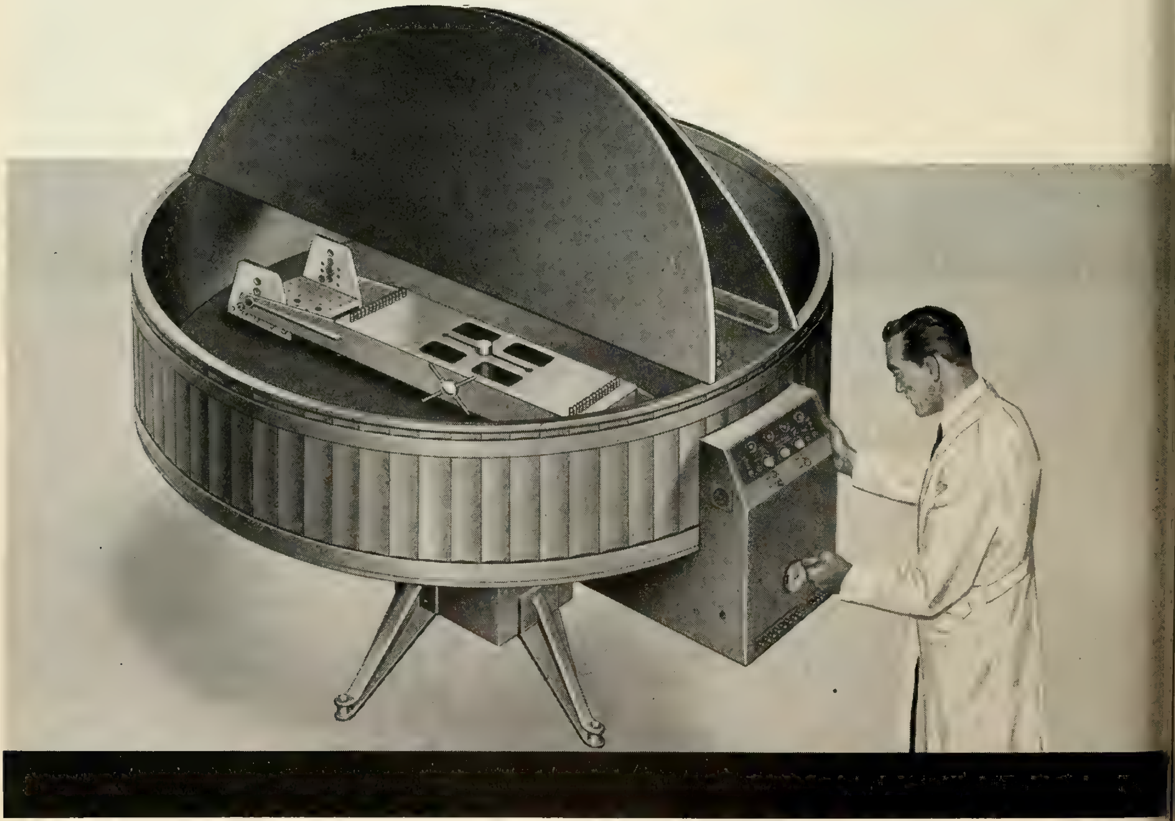
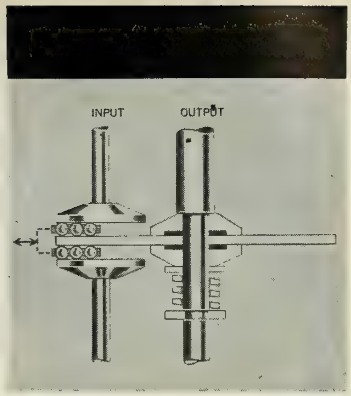




Entirely new, more efficient drive system—An integral variable speed transmission based on the new *Rouverol* *ball-galaxy principle achieves, for the first time in rotating machinery, high torque characteristics while maintaining the inherent accuracies of a hardened steel-to-steel ball-disc integrator. A novel choice of geometry among the drive elements results in a virtually linear handwheel vs rpm relationship, thus facilitating the presetting, programming and servo-controlling of output speeds. A built-in torque-limiter clutch protects the transmission from damage resulting from abuse or high inertia conditions.

*Pat. Pending

The low-cost answer to fast,
accurate testing of components under
simulated operational g-forces
as required by MIL-E-5272A.

These new precision centrifuges feature a unique, high-torque ball-disc integrator drive system which provides accuracies you would expect only from a rate-of-turn table. Constancy of boom rotation, including wow and long-term drift, is better than .05% at any speed setting—approximately 10 times more accurate than currently available machines. Boom speed is infinitely variable and is measured by an electronic counter built into the console.

The building block design concept gives the new centrifuges exceptional flexibility. Machines are assembled from six basic off-the-shelf components; drive system, drive motor, boom, test compartment, console and accessories. You simply select components which provide features needed to meet your specific requirements. Interchangeability of the components permits easy modification as requirements change. Kits are available for modification by the customer.

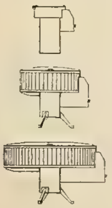
This new design concept also results in manufacturing economies which are reflected in the cost of the machines. *The new machines are the lowest priced centrifuges now available—in spite of their greater accuracy, flexibility and capacity.* Ask your Genisco representative for complete information today.

There are more than 400 Genisco centrifuges now in operation.

Genisco
INCORPORATED

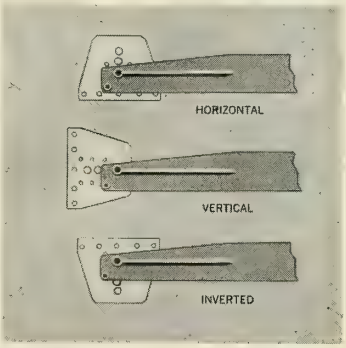
2233 Federal Avenue, Los Angeles 64, California

brief performance specifications



Model No.	Diameter	Test Object Weight	Capacity G-pounds	RPM Max.	G-Range Max.	Test Object Dimensions
A-1010	30" table	50 lbs. dead weight	2,500	800	.1 to 200 g's	
A-1020	60" arm	100 lb. dead weight	10,000	600	.1 to 250 g's	12" cube
A-1030	96" arm	100 lb. dead weight	10,000	400	.1 to 175 g's	18" cube

Large custom centrifuges: Genisco centrifuge experience includes the design, manufacture and installation of large custom-built machines. We invite your inquiry.



Basket-type mounting platforms, available on Model A-1020 and A-1030, may be oriented from the horizontal to the vertical or to the inverted attitude for multiple-axis testing without demounting the test object. Baskets may be raised or lowered to achieve an optimum dynamic balance and minimum angular deflections when extreme accuracies are required. When the basket is inverted the outside surface of the platform may be used to mount bulky, lightweight packages.

Available accessories include additional slip rings, servo control, microwave joints, high pressure air and hydraulic systems, TV viewing systems. Any accessory can be added *at any time* by the user. The mounting base is standard equipment.

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IMPORTANT DEVELOPMENTS AT JPL

PIONEERS IN EARTH-SPACE COMMUNICATIONS

The exploration of outer space will take a new step forward with the completion of the new giant radio antenna being installed by JPL near Barstow, California. This huge "dish," 85 ft. in diameter, will enable the Laboratory scientists to probe still farther into space problems.

Information thus obtained and combined with lessons still being learned from the successful Army "Explorer" satellites, will provide invaluable basic data for the development of communication systems to serve space exploration programs. Long range communication will begin as a one-way link from space to earth, developing later into tracking and communicating with lunar vehicles at far greater ranges.

This activity will be part of a great research and development program to be operated jointly by JPL and the United States Army Missile Command.

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COVER: *Scott Crossfield, North American's test pilot for the Air Force X-15, is shown in a simulated cockpit of the rocket research craft in one of the many tests that have been conducted during the development program. The first of three X-15s is scheduled to roll out of the Los Angeles Division's fabrication shop Oct. 15 (see page 17). First powered flights are scheduled for Spring of 1959.*

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in this issue

OCT. 6 HEADLINES

First "Instruction Missile" Firing Set
Troops in training at AF's Vandenberg base will be ready soon to fire *Thor, Atlas,* and *Titan* 13

***Titan* and *Atlas* Both Safe, Will be Continued**
Chances of discontinuing either system seen so small as to be no cause for concern to manufacturers, services 13

AFA Calls for Single Armed Force
Meeting endorses demand, service groups oppose 14

X-15 Rollout Due October 15
Actual flight is still months away, final engines haven't been completely tested. Vehicle will bridge technology gap 17

Space Logistics Occupies AF Brass in Seminar 18

Navy Confident It Can Meet IRBM Schedules 21

ASTRONAUTICS ENGINEERING

Basic Sciences Must Be Part of Space Team
L. Eugen Root, head of Lockheed development planning department, sees industry's role in space exploration 31

Precise Limits of Accuracy in Shooting Planets
Contributing Editor Frederick C. Durant III outlines what will be needed to reach Venus, Mars (World Astronautics) 52

MISSILE ELECTRONICS

Job for Electronics: Weighing Big Missiles
Techniques of determining center of gravity of big birds with all their parts, calls for special equipment 23

Communications With Space Vehicles
m/r Associate Editor discusses a new development to improve communications between earth and space (Astrionics) 25

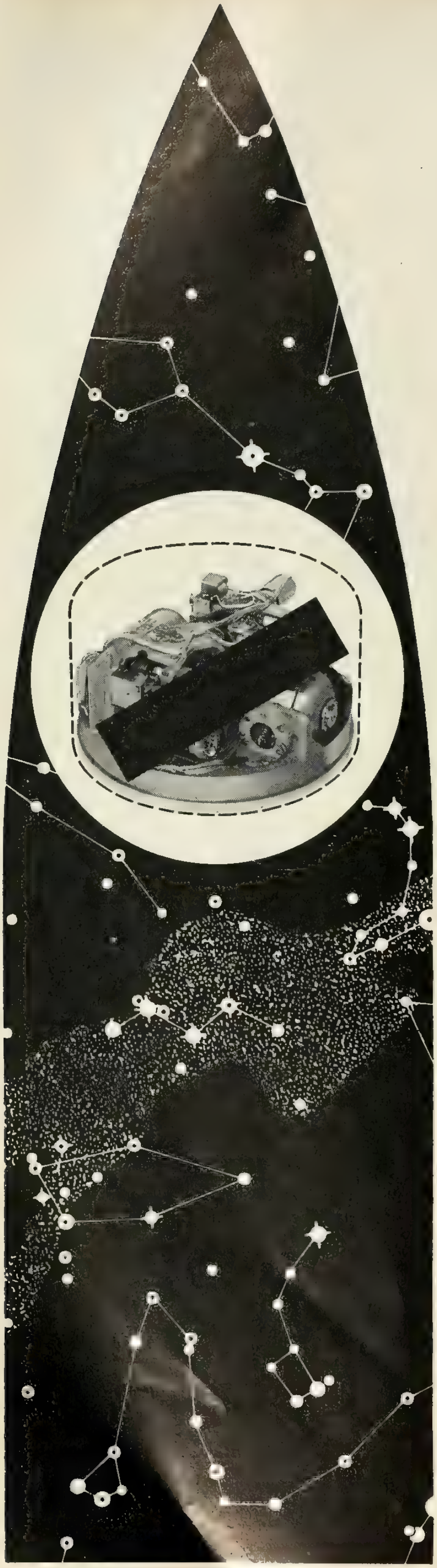
Personnel Problems Plague Electronics Industry
West Coast Editor discusses situation facing electronics firms in their search for qualified engineers (Missile Business) 44

GE Shows Plasma Accelerator 29

Electronics Industries Assn. Admits New Members 24

DEPARTMENTS

Industry Countdown 9
Washington Countdown .. 11
Missile Electronics 25
New Missile Products 35
Contract Awards 47
When and Where 50
Letters 51
Book Reviews 55
Moscow Briefs 56
Editorial 62



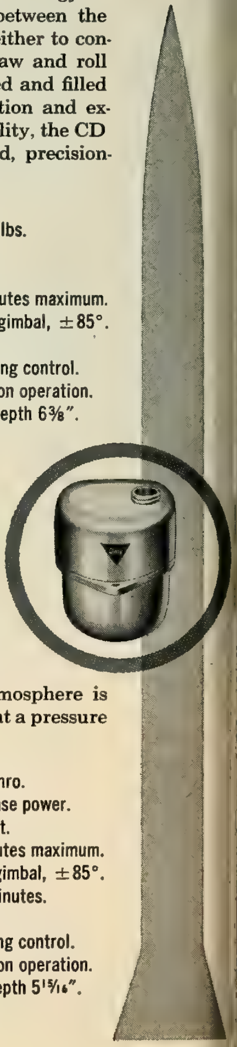
For high reliability under extreme environmental conditions, specify

Clary Gyros

The Clary CD 600 electrically driven amount gyroscope is a self-contained, three-gyro package consisting of three gyros mounted on a single bracket with pick-offs between the outer gimbals and the frame. It may be used either to control flight, or to transmit changes in pitch, yaw and roll attitudes. The entire unit is hermetically sealed and filled with dry helium. To withstand high acceleration and extreme vibration, and to insure maximum reliability, the CD 600, like all Clary gyros, is ruggedly designed, precision-manufactured and extensively tested.

GENERAL SPECIFICATIONS

Weight: DC system, 19.25 lbs.; AC system, 15.0 lbs.
Pick-off: Potentiometer or synchro.
Power Requirements: 27 V DC; 115 V AC.
Vibration: 10g at 20 to 2000 cps. • Warm-up Time: 2 minutes maximum.
Gimbal Freedom: Outer gimbal, 360° (continuous); inner gimbal, ±85°.
Drift Rate: Scorsby test .5° per 5 minutes.
Caging Operation: Remote electrical caging and uncaging control.
Temperature: $-30°$F to $+160°$F. • Altitude: No effect on operation.
Humidity: No effect on operation. • Size: Diam. 10", depth 6⅜".



The Clary CD 750 electrically driven amount gyroscope is primarily designed to control attitude of short range "artillery type" missiles such as the Corporal, Sergeant and others within the 500 mile range, where vibration and steady state accelerations are moderate to heavy. Separate pick-offs are provided for each axis, and the instrument incorporates a DC solenoid-operated caging mechanism to orient the gimbals with respect to the mounting surface. Internal atmosphere is $-75°$ F dew point nitrogen with helium tracer at a pressure of 15 p.s.i.a.

GENERAL SPECIFICATIONS

Weight: 5 lbs. • Pick-off: Potentiometer or synchro.
Power Requirements: 115 V line to line, 400 cps, 3-phase power.
350 ma starting current, 70 ma running current.
Vibration: 10g at 20 to 2000 cps. • Warm-up Time: 2 minutes maximum.
Gimbal Freedom: Outer gimbal, 360° (continuous); inner gimbal, ±85°.
Drift Rate: Scorsby test. ***Heavy rotor:*** .5° per 5 minutes.
Light rotor: .5° per minute.
Caging Operation: Remote electrical caging and uncaging control.
Temperature: $-30°$F to $\pm160°$F. • Altitude: No effect on operation.
Humidity: No effect on operation. • Size: Diam. 4³⁄₁₆", depth 5¹⁵⁄₁₆".

Clary

CLARY DYNAMICS
Dept. RM-58, San Gabriel, California

industry countdown

"Fantastically close tolerances . . ." are being called for in construction of the 5-foot-diameter aluminum sphere for the WS 117L reconnaissance satellite. Some industry representatives are beginning to express concern over how quickly our space-age requirements are advancing, in contrast with the slower pace of what is possible.

A place on the N.Y. Stock Exchange... is being reserved for Thiokol Chemical Corp., according to informed Washington brokers. Thiokol, which has produced all successful *Polaris* engines to date, is the only officially-listed supplier for *Bomarc* boosters.

Missile money for small business . . . is still the aim of many Congressmen, some of whom are pressing for immediate appointment of an official in the Pentagon Research and Engineering Office for the purpose of stepping up small business participation in missile programs. A report by the Subcommittee on Government Procurement of the Senate Small Business Committee says that Missile Director William Holaday has displayed a "disappointing lack of appreciation made to our defense effort by smaller firms in the past."

A large beryllium R & D contract . . . has been let by the Air Force to the Beryllium Corp. in an effort to obtain a method for producing ductile castings of the metal. Beryllium, which USAF uses in its nose cones for ballistic missiles, has heretofore been available in machined form only after a lengthy, costly process. The final cost of the metal is expected to be reduced if the research is successful.

A 50-nation distribution net . . . has been acquired by Litton Industries through its purchase of Westrex Corp., a subsidiary of Western Electric Co. Westrex will distribute Litton communication equipment, radar antennas, and other products. Gross income for Westrex in 1957 was $13 million.

Biggest U.S.-sponsored . . . technical meeting ever held was the fourth annual Military-Industry Packaging and Handling Symposium, Sept. 30-Oct. 2 in Washington. Divided into 18 panels, those attending heard more than 130 speakers.

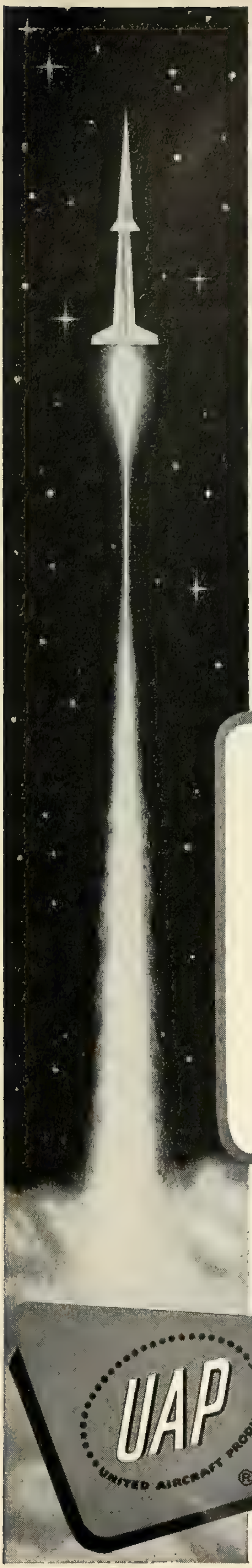
Purchase of Gruen Electronics . . . division for $1½ million has been completed by Divco-Wayne Corp. of Richmond, Ind. The sale marks the entry of Divco-Wayne, makers of specialized vehicles, into the missile electronics market. Divco-Wayne had sales of $28 million in 1957, and employs 624.

A wage increase . . . of 3% has been granted Servomechanism's Inc. 1100 employes. SMI indicated that the increase was part of a policy of maintaining its wage levels above the industry average. The boost, effective August 4, excludes those earning more than $15,000 annually.

A share of *Bomarc* production . . . is what the Canadian government is seeking in order to offset the effects of the Avro CF-105 cancellation. Discussions are expected to be held with Boeing and the U.S. government on the best way Canadian industry may share in *Bomarc's* production. The Avro *Arrow* and *Sparrow* II were cancelled simultaneously. Avro employs 11,000.

European-made missile parts . . . will not be bought by USAF, according to AMC's General Rawlings. This apparently rules out foreign licensing of either *Thor*, *Atlas* or *Jupiter* components. It does not, however, entirely preclude the purchase of some ground support equipment in England or the continent under the AF offshore procurement program.

$135 million *Nike-Zeus* contract . . . for research and development of the anti-missile missile has been awarded by Army to Western Electric, N.Y. Douglas Aircraft and Bell Telephone laboratories are major subs.



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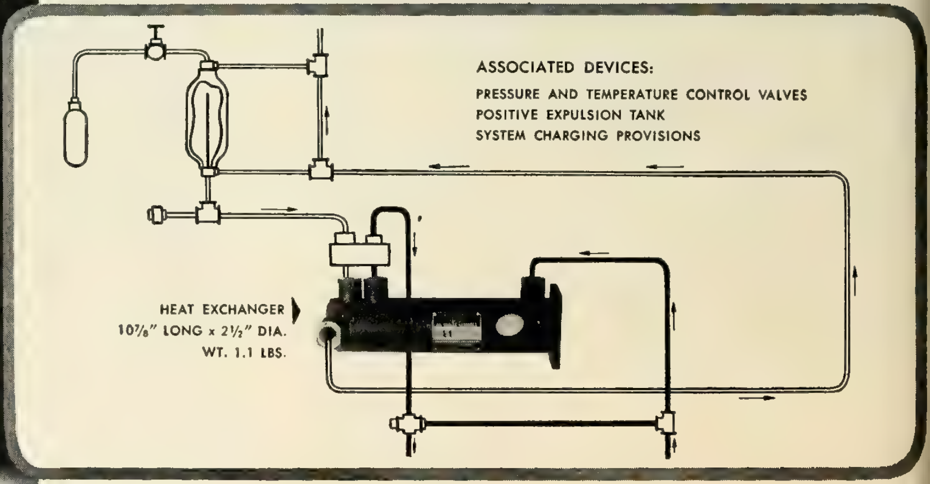

More specific information in Engineering Report form can be made available to qualified inquirers by contacting UAP Contractual Engineering Offices.

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washington countdown

Mathematicians, not generals . . . will staff SAC's new Missile Trajectory Center, which will be something of a counterpart to the command's great communications and bomber control center at Offut AFB, Omaha. Purpose will be to calculate vast numbers of trajectories for ballistic missile squadrons.

Far from dead . . . is AF's anti-missile Wizard program. In addition to the detection phase—which AF was authorized to continue—research goes on into certain other facets. Wizard—with Convair as contractor—is based on area-defense concept, as opposed to Army's point-defense theory. Some extra, but limited, AF funds are possibly being provided.

***Minuteman's* first stage . . .** developing 135,000 lbs. of thrust for 45 seconds, was static-fired for the first time last week by Thiokol, at Redstone arsenal (though it hasn't been officially confirmed by DOD). Early firing should mean considerable shortening for the weapons system. Second stage, which had a reported propellant weight of 37,000 lbs., has a 6½ ft. diameter, and is 27 ft. in length. Prime contractor for *Minuteman* will be named, and contract awarded, within 60 days. Some 30 proposals have been entered.

First space warfare . . . won't be within possibility until USA and USSR have capability of putting offensive spacecraft over each other's territory, according to Gen. Thomas Power, SAC commander. Such craft are not yet "anticipated," he added. But just how far thinking has gone along these lines was also reflected at AFA meet in Dallas (where Power spoke) by Dudley C. Sharp, assistant AF secretary for materiel. Said Sharpe: AF will become space force in time, and AF interest in space operations is only so far as a military application is concerned.

US equatorial launching sites . . . depend, at the moment, on allocation of responsibility for such satellite orbiting programs. Logically, this responsibility would go to NASA. Possibilities for location include Christmas Island, or equatorial South America or Africa. Estimated cost: site, $100 million; vehicle, $100 million.

First operating test *Titan* . . . is expected to be accepted by AF any day now, with initial firing possible this month (see p. 17).

***Atlas* ICBM is now . . .** air transportable. By removing forward section, missile can be packed into turbojet C-133.

The missile-carrying B-58 . . . is probably more solidly in the Air Force inventory today than ever before, although certainly not secure. Reasons: tough Vice Chief of Staff General LeMay likes it better and better, and, equipped with the MB-1 atomic air-to-air rocket, it looks good as a long range interceptor.

Naval Research Lab . . . is convinced that SLV-3 made at least two orbits of the earth before plunging back into the earth's atmosphere. A pick-up was made at the Antofagasta, Chile, minitrack at a time that would coincide with a second revolution. Although a station in South Africa reported sighting what they believed to be the satellite a few hours after launch, NRL firmly believes the ball fell after a maximum of three or four orbits.

Military Weather Satellite . . . prime contract has been given Radio Corporation of America's Astro-Electronics Products Division, Princeton, N.J. Project is under managerial control of Advanced Research Projects Agency, but official DOD confirmation of the award has not been made. Air Force probably is cognizant service, but launch vehicles (modified *Jupiters*) may be supplied by Army Ordnance Missile Command. Less than six instrumented satellites are involved at this stage.

Note—Commercial and Military Packaging Engineers:

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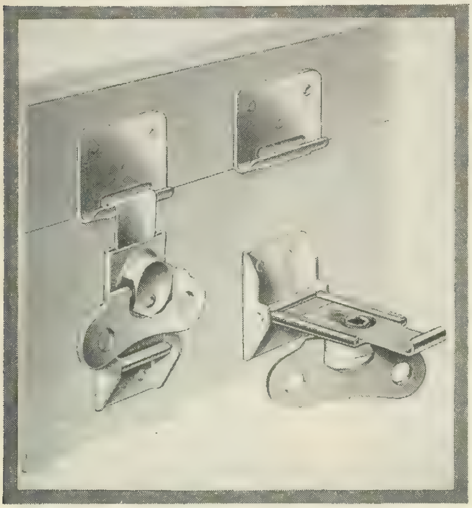

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CASE, TRANSIT, PERISCOPE, 6551000
CASE 8 OF 19

Photograph courtesy of Craig Systems, Inc.

LINK-LOCK provides pressure-tight closure on this rigidly specified equipment container

Simmons LINK-LOCK provides quick opening and closing as well as impact-resistant dependability on transit cases manufactured by Craig Systems, Inc., Danvers, Mass.

The cylindrical Craig container above is gasketed and pressure-tight, and contains delicate electronic equipment. Twelve LINK-LOCK fasteners are used on this model.

Here's why LINK-LOCK is ideal for use on military cases produced to exacting specifications as well as on inexpensive commercial containers:

- Impact and shock resistant (positive-locking).
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OCTOBER 6, 1958
VOL. 4, NO. 14
missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

First "Instruction Missiles" Ready To Fire

Vandenberg Sets Date For Blast-Off Of *Thor, Atlas, Titan*

VANDENBERG AFB, CALIF.—The historic first firing of a ballistic missile—an intermediate range *Thor*—from this first U.S. ballistic missile training center will take place late in November or early December.

Technicians from Douglas, builders of the *Thor,* will install the missile. Air Force technicians-turned-instructors will fire it under the eyes of ballistic trainees from the U.S. and several other countries.

The first ICMB *Atlas* will be fired from Vandenberg next spring, probably under the same conditions, with Convair installing.

The first *Titan* is expected to be fired from Vandenberg in about one and a half years, probably—March or April of 1960—although this is a tenuous date at the present.

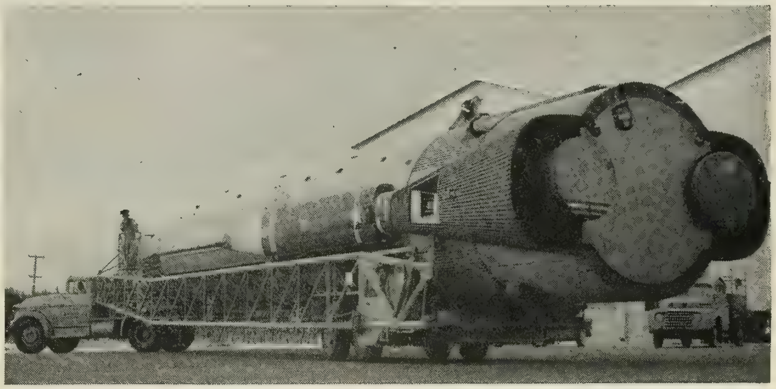
These will be the first major ballistic firings, except over the Cape Canaveral range, and the first for instruction purposes as opposed to testing purposes. The firings coincide roughly with the dates the weapons are expected to become operational—the *Thor* in England and the *Atlas* and *Titan* from U.S. bases.

• **Pacific range site**—Firings will be over the Pacific Missile Range operated by the Navy. This range encompasses a strip 500 miles long paralleling the California Coast and extending 250 miles into the Pacific. Beyond that, test corridors extend sufficient thousands of miles to sea to handle firings of both IRBMs (1,500 miles) and ICBMs (5,500 miles).

Tracking stations are located along the coast of California and in Hawaii, with others to be added. These will be augmented at times of firings by Navy instrumentation ships, which will also record data telemetered from the missiles. Other vessels will patrol areas temporarily closed to shipping.

Maj. Gen. David Wade, first U.S. ballistic missile commander and boss of Vandenberg, has already accepted two *Thor* firing pads from the contractors. Acceptance of three *Atlas* pads is expected shortly. Two *Atlas* gantries are already up.

Originally Camp Cooke from World War I days, and then Cooke AFB when the Air Force took over the 64,000-acre training center, the name was officially changed on Oct. 4 to Vandenberg Air Force Base in honor of the late AF chief of staff, Gen. Hoyt S. Vandenberg.



FIRST MISSILEMEN undergoing training at Vandenberg AFB (Cooke AFB) practice transporting an *Atlas* ICBM. The missile is hauled on a specially designed trailer from the missile assembly building (background) to the launch pad located approximately 7 miles distant. In addition to the driver, a missileman standing near the nose cone directs the operation by intercom. The man in the compartment under the engines, at the rear of the carriage, steers the trailer.

Titan and *Atlas* Are Both Safe

WASHINGTON—The chances that the Air Force will drop Martin's *Titan* ICBM are so small as to be almost non-existent.

The *Titan* is a war machine designed to travel 5,500 nautical miles and knock out a hardened target within a reasonable CEP. Peacefully, it is designed to boost heavy payloads into space.

In the present state of the missile art, the *Titan* is a fairly sophisticated vehicle. Its two-stage design gives it a much greater potential than earlier one-and-one-half stage weapons, in that the second stage can be used with newer and more power fuels as they are developed.

The *Titan*'s running mate, the Convair *Atlas,* also has a very secure place in the Air Force arsenal. Despite its most recent failure to fly the full designed range, the *Atlas* previously had three successful firings in a row. Eventually, of course, the *Atlas* will be phased out and replaced, quite probably by the *Titan.* But it is far enough ahead of the *Titan* that there is no thought in the Air Force, at the moment, of reducing its heavy procurement schedule.

Present plan is soft bases for the *Atlas,* hardened sites for *Titans.* Neither can be replaced by the smaller ICBM *Minuteman,* programmed for about 1962. The *Minuteman* is smaller and lighter, but carries a much smaller warhead.

Rumors of the *Titan*'s cancellation have come from two sources. The first is Defense Department Missile czar William M. Holaday. who has long been sniping at that particular program. Mr. Holaday's reasons are his own.

The second is a small group within the Air Force itself, who have advocated doing away with the *Titan* program and purchasing more B-52s. Even they, of late, have concurred with the general sentiment in the Air Force that this would be a giant step backward.

Nearly half a billion dollars have been spent to date on the *Titan* development program, and its sub and sub-sub contracts are scattered among 4,000 suppliers in 38 states. Static tests on the missile have been underway for months. One missile is already in the test stands at Cape Canaveral, but it is for checking out ground equipment only. The Air Force is expected to accept the first production test vehicle any day.

AFA Urges Single Armed Force

Texas Meeting Endorses Call For One Military Dept.; More Money For R&D; Increase In Armed Forces

DALLAS—Most important announcement made during the AFA convention here—attended by some 4,000 people—was the unanimously passed AFA Statement of Policy emphasizing that "we desperately need consolidation of our three military departments into *one* for efficiency, economy, coordination and the ability to respond instantly, with a maximum effort, in time of national emergency."

The statement outlines AFA's immediate concern with two of the fronts on which the Free World is fighting a war for survival; the first is the technical front, the second involves the capability of our present military forces.

"Under the current programming," the statement continues, "the Free World is losing ground on both fronts. Soviet strength and striking power continue to grow at a more rapid pace than our own. Our margin of security continues to dwindle. The Soviet lead in the satellite race should make this fact clear.

"Our peril would be clearer to the American people if our leaders make candid acknowledgement of their estimates of current and future Soviet forces to be posed against us—forces which daily grow more dangerous to our survival.

"In the face of this danger, we must better integrate our efforts upon both fronts. We must concentrate on weapons systems best designed to cope with the threat and ruthlessly eliminate the others. Service tradition and rivalries are inefficient and expensive luxuries that do not add to our national defense."

The statement also calls for increased expenditures for research and development of future forces appropriate to the changing threat, as well as an increase in today's forces to match the current threat, in order that our national defense effort can be expanded without endangering the economy.

The strong conclusion of the AFA Policy Statement reads: "We believe the people of the United States should be frankly informed of the grave danger in which they live. Any policy or program, no matter how costly, which leaves a margin or doubt that it is sufficient to meet the growing threat. involves an unacceptable risk to our nation's security. We believe the American people are currently being asked to take this risk without their full knowledge and understanding."

• Other Convention Highlights—

• USAF Ballistic Missile Division commander, Maj. Gen. Bernard A. Schriever, was named "Aviation's Man of the Year," and was awarded the AFA's General H. H. Arnold trophy.

• Gen. Thomas D. White, chief of staff, U.S. Air Force, said in a statement before the Space Age luncheon: "I want to point out that Air Force efforts, experience and capabilities in research on space operations are being oriented entirely toward development of military capabilities, which will assure that we can extend our air superiority into space. We recognize that the Air Force mission in space is solely a military mission—one which requires us to develop and produce military vehicles. However, Air Force experience and capabilities will always stand ready to assist in other fields if they are needed."

• Dr. Hugh L. Dryden, deputy administrator of NASA, said: "In my personal opinion, it is factually incorrect to state that the only proper justification for supporting work in space is military. Plainly, it is a perversion of the facts to suggest that all non-military space activity should be considered mere 'fun in space'."

• The Airpower Panorama demonstrated that we are in a definite period of transition from aircraft to space craft.

• General Electric's working model of its pulsed plasma accelerator, shown at the Panorama, produced a thrust of three-tenths of an ounce, sufficient to change the direction of a vehicle in the near-perfect vacuum of outer space.

Army and Navy Groups Oppose AFA Views

Unanimous adoption by the Air Force Association of a policy in favor of a single service brought immediate response from the AFA's opposite numbers.

In a special statement to m/r, John J. Bergen, president of the Navy League, said:

"The Air Force Association statement of policy advocating a single force does not appear to have much practical meaning in view of the legislation passed by Congress this past summer.

"You cannot increase breadth of knowledge of individuals by issuing an edict. Experts in land, sea and air warfare are still needed. The machinery already exists at the Department of Defense level to eliminate unnecessary duplication.

"I believe it would be a great disservice to the cause of defense efficiency to press for such a dangerous and drastic proposal."

Speaking for the Association of the U.S. Army, Lt. Gen. Walter L. Weible, USA (Ret.), executive vice president, called attention to the policy adopted at last year's meeting, urging membership to "actively support maintenance of the separate identity of the services, including the assurance that all shall have parity of expression of their views in the highest executive and legislative councils."

The AUSA policy was adopted, the resolution said, in view of no evidence that a single service or Chief of Staff would promote efficiency and economy, and that a single service would stifle initiative and lower competition spirit.

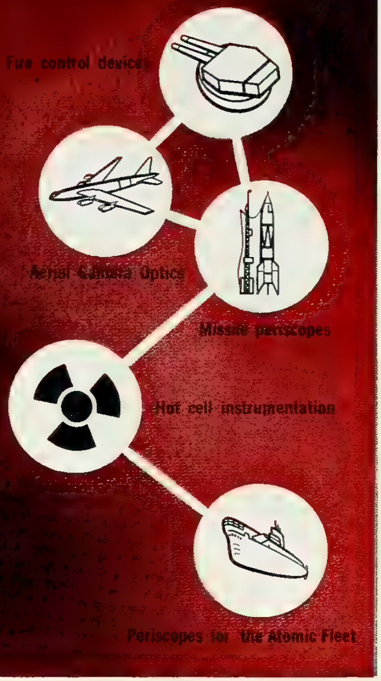
AFA To Sponsor World Congress of Flight

DALLAS—Peter J. Schenk, President of the Air Force Association announced here that the association will sponsor the first World Congress of Flight to be held at Las Vegas Nevada, between April 12 and 19, 1959.

The Congress, which is expected to be the biggest of its kind, will cover the Jet Age, the Missile Age, and the Space Age. Although an estimate on number of participants was not available, it was said that the attendance will be international.

AFA's Fourth Annual Jet Age Conference (originally scheduled for late February in Washington) will be featured along with a Missile Management Conference and a Space Age Conference. The two latter will be sponsored by AFA's Space Education Foundation.

An international exposition—including an exhibition of aero-space equipment—similar to the Farnborough show is planned in conjunction with the congress.



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AMERICAN BOSCH ARMA CORPORATION

X-15 Scheduled to Make Debut Oct. 15

by Norman L. Baker

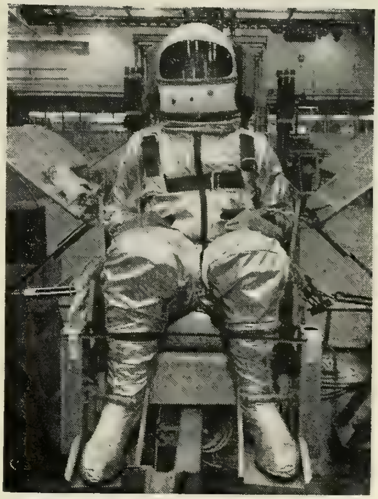
WASHINGTON—The completed package of the X-15, the most advanced concept in the aeronautical and astronautical vehicle design state of the art, will roll through the doors of North American's Los Angeles Division sometime next week.

This, the first of three under construction and the latest generation of a series of advanced research craft, is destined to probably play the most history-making role of all the X series of aircraft. The X-15 must bridge the gap between two eras of technology—the transition from aerodynamics to the virtually unexplored field of astrodynamics.

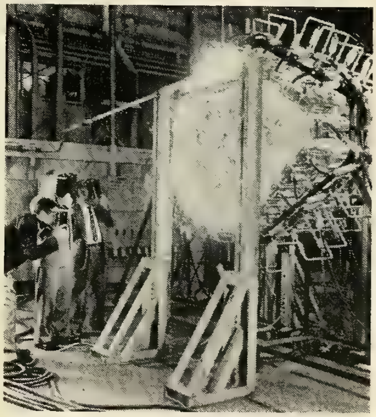
The role of the X-15 is similar in many respects to the famed X-1 sonic-barrier research vehicle. Both were designed for an assignment that would involve the searching of the 'gray' limits of man's knowledge of flight. Both of the vehicle's designs were based on unproven theories, theories that can be proven only by actual flight test in the environments for which they were designed.

• **Flight weeks away**—The space research phase of the X-15 is still many weeks away. The vehicle is expected to roll from NAA's plant minus its Reaction rocket power plant. At last report the engine was still in its final test program at the Reaction plant.

NAA test pilot Scott Crossfield will take the craft through an extensive 'wringing out' program before it is delivered to the Air Force early next spring. This first phase of a three divisional operation will carry the vehicle through an involved 'air worthiness' check-out starting with unpowered glide flights, through high altitude powered flights with ballistic attitude control system. Crossfield will make no attempts to take the X-15 through its maximum of velocity and altitude. After North American is satisfied with its 'de-bugging' and evaluation program, the vehicle will be turned over to the Air Force research team at Edwards Air Force Base.



FLIGHT SUIT protects pilot in X-15 flights.



COCKPIT AREA tested for heat, cold.

At Edwards, the X-15 will be tested to the limits of its design capabilities by a team of fliers headed by Capt. Robert (Bob) White. In a series of small steps this team will gradually move farther out into the space environment and deeper into the hypersonic regime. The X-15 will quickly enter the transition area between the atmosphere and true space conditions investigating control, orientation, and stability in this critical area. As the vehicle goes through a ballistic arc in its flight pattern, the pilot will be subjected to acceleration, weightlessness, and deceleration where his ability to perform the functions of controlling the vehicle will mean the difference between success and failure.

• **Parallel program**—NACA will join the Air Force at Edwards in a parallel research program. While the Air Force tests will be of a current vehicle design evaluation nature, NACA will conduct detail flight research for later generation space research vehicles. Heading the NASA flight team will be Joseph Walker with a backup by Neil Armstrong.

During all research flights, the NASA will have primary responsibility. It also will operate the flight test range between Wendover AFB (the position of launch of the X-15 from the B-52) and Edwards AFB, and will be responsible for data reduction and reporting.

Unlike the preceeding rocket aircraft research programs, where only one vehicle was available for testing, all three X-15s will be going through their paces throughout the program. In addition to accelerating the program, this procedure will preclude any holdup in case of destruction of one of the vehicles.

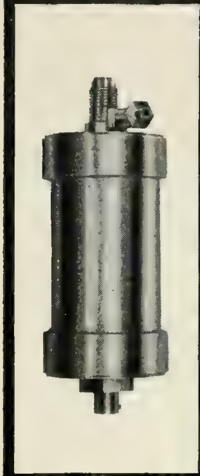
• **Manned missile**—The X-15 is for all practical purposes a manned ballistic-glide missile. Its 50-ft. cylindrical fuselage resembles current finned ballistic missiles. The cockpit payload is located well forward in the nose, followed by the propellant tanks and the 60,000-lb. thrust rocket engine system. Controls, plumbing and wiring are routed along the fuselage through two large projecting tunnels on either side of the ship.

Midway on the fuselage is mounted the thin supersonic wings with large radius leading edges (for dissipation of heat) and blunt trailing edges. The vertical and horizontal tail surfaces are extremely blunt on the trailing edges. Only the top vertical fin moves for directional control while the horizontal surfaces are all-movable. Landing gear (skids in the rear and nose wheel) is identical to the late X-2.

• **Clothed in steel**—The X-15 is an all-steel craft, clothed in nickel alloy steel, titanium and stainless steel to combat high aerodynamic heating. The outer skin, designed to absorb the initial heat buildup, is nickel alloy with stainless steel and titanium on the inside. The use of aluminum for internal use is held to a minimum. The side panels are chemically milled after forming for additional weight saving.

Manufacturing techniques are similar to those used in the construction of missiles, marking a transition in the fabrication of manned systems. About 65% of the X-15 will be welded structure, compared with 100% fastened structures for current aircraft systems. Automatic and resistance welding has been used in joining the structural frame.

The heat-resisting structure of the X-15 is reported, by North American,



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. . . X-15 Rollout Scheduled

to be the key to the vehicle's design. Exhaustive temperature tests consumed a major portion of the development program. Although the engineers were more concerned with external aerodynamic heating, all the internal structure was subjected to heat tests under external pressure and bending loads. Little damage to the structure of the X-15 is expected as a result of its characteristic of constant and rapid flight through critical temperature areas. During re-entry certain areas of the ship's skin may reach a temperature of 600 degrees C, leading edges and control surfaces will top 1000 degrees C.

• **Program in sixth year**—The X-15 project was initiated in 1952 when NACA directed its laboratories to begin studies for the problems likely to be encountered in flight beyond the atmosphere and the methods of exploring them. By the spring of 1954 the characteristics of the craft necessary for this investigation had been determined. Independent proposals of the Air Force Scientific Board, the Navy Bureau of Aeronautics and NACA were submitted as a joint proposal to the Asst. Secretary of the Air Force for Research and Development with the resultant DOD approval in December 1954. Nineteen hundred fifty-five was a year of heavy design competition for the X-15 by several contractors having experience in the design of high altitude, high velocity airplanes. North American was given the go-ahead in December 1955 with a contract to build three X-15s with the Air Force providing the bulk of the funds (approximately $100-million) for the design, construction, and support of the research craft, in addition to supplying the mother B-52.

AF INDUSTRY AND RESEARCH LEADERS discuss space logistics. (Left to right) C. N. Zimmerman, NACA; Brig. Gen. L. B. Kelley; S. H. Dole, Rand Corp.; Brig. Gen. H. A. Boushey.

Reliability Stressed As Key to Space Logistics

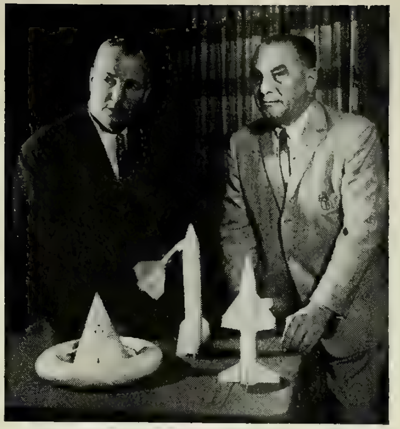
MAXWELL AFB, Ala.—Reliability is the biggest single factor in solving the logistics problems of space travel and exploration. This was one of the conclusions reached by representatives of industry, several government agencies and key Air Force personnel at the 10th AF Long Range Logistics Discussion Group meeting at Maxwell AFB last week. This was the first such conference devoted to the problems of supplying space stations and vehicles.

"We are meeting here to get a feel for the future," said Brig. Gen. L. B. Kelley, Director of Logistics Plans, USAF Headquarters, "so that we can better anticipate the problems."

Gen. Kelley emphasized that the meeting was not for the purpose of discussing any AF program or any national program, but only to explore generally the logistics implications of space, and to determine the lines along which the Air Force should be thinking.

Some 65 persons from AF, industry and government agencies attended the closed sessions. A series of lectures was given on practically every aspect of space and followed by a brief discussion period. These lectures included: The Space Environment—S. H. Dole of the Rand Corp.; General Space Activities—C. H. Zimmerman, NACA; Keeping the Spaceman Alive—Col. C. H. Roadman, USAF; Astrodynamics of Space Vehicles—Dr. W. R. Dornberger, Bell Aircraft; Reliability and Development Testing—Maj. Gen. L. I. Davis, USAF; Space Vehicle Design—Dr. Krafft Ehricke, Convair; Propulsion for Space Vehicles—Lt. Col. P. G. Atkinson, USAF; The Development of Space Law—Mr. J. A. Johnson, Chief Counsel of the AF; and Military Use of Space Vehicles—Brig. Gen. H. A. Boushey, USAF.

An invitation
to
senior scientists
and
engineers



A $14,000,000 R & D Center, housing 9 new laboratories, was revealed as core of Republic's $35,000,000 Research and Development Program at recent announcement by Mundy I. Peale, President, and Alexander Kartveli, Vice-President for Research and Development.

....To join Republic Aviation's new $35 million Research and Development Program for spacecraft, missiles and advanced aircraft

In announcing Republic's $35 million research and development program, designed to arrive at major breakthroughs in the aviation industry's transition to astronautics, Mundy I. Peale, President, set the following objectives:

> "...ACCELERATION OF PROJECTS ALREADY UNDER WAY AT REPUBLIC ON LUNAR PROGRAM FOR MANNED SPACE VEHICLES, AND MISSILES TO DESTROY ORBITING WEAPONS, AND INITIATION OF INVESTIGATIONS LEADING TO NEW CONCEPTS FOR INTERPLANETARY TRAVEL."
>
> "...RADICAL NEW FAMILIES OF LONG-RANGE AIR-TO-AIR MISSILES AND AIR-TO-SURFACE BALLISTIC MISSILES FOR STRATEGIC AND TACTICAL AIRCRAFT."
>
> "...VERTICAL TAKE-OFF FIGHTER-BOMBERS, HIGH-MACH FIGHTER-BOMBERS, AND SUPERSONIC TRANSPORTS."

Alexander Kartveli, Vice-President for Research and Development, emphasized that Republic's program "will not duplicate in any way investigatory work currently in progress elsewhere, but will stress novel concepts and new approaches to basic problems of missiles and space technology."

The program includes construction of a $14 million R & D center to house 9 new laboratories, and anticipates doubling the present research staff.

Senior men interested in the new possibilities created by a simultaneous exploration of all aspects of Flight Technology are invited to study the functions of the new laboratories for more detailed information:

SPACE ENVIRONMENTAL DEVELOPMENT LABORATORY
To simulate space flight conditions and test missile, satellite and spacecraft systems and components; investigate human engineering problems.

RE-ENTRY SIMULATION & AERODYNAMIC LABORATORY
To study hypersonic shock dynamics, real gas effects, heat transfer phenomena and magnetohydrodynamics.

MATERIALS DEVELOPMENT LABORATORY
Study effects of high velocity, temperature, and space environment on materials for spacecraft, missiles and advanced weapons.

GUIDANCE & CONTROL SYSTEM DEVELOPMENT LABORATORY
To develop and test guidance and control systems for spacecraft, missiles and aircraft.

ELECTRONICS DEVELOPMENT LABORATORY
Study and explore all problems connected with highly specialized, complex electronic systems required for advanced forms of spacecraft, missiles and aircraft.

ADVANCED FLUID SYSTEMS DEVELOPMENT LABORATORY
To develop and test fluid power systems for spacecraft and missiles capable of operation under extremely high temperature, high pressure conditions.

MANUFACTURING RESEARCH & DEVELOPMENT LABORATORIES
To develop advanced manufacturing processes and techniques for materials used in missiles and spacecraft. Laboratories for each of the following areas: *Non-Metallics, Metallics, Welding.*

Qualified men are invited to write directly to:
A. Kartveli, Vice President, Research and Development

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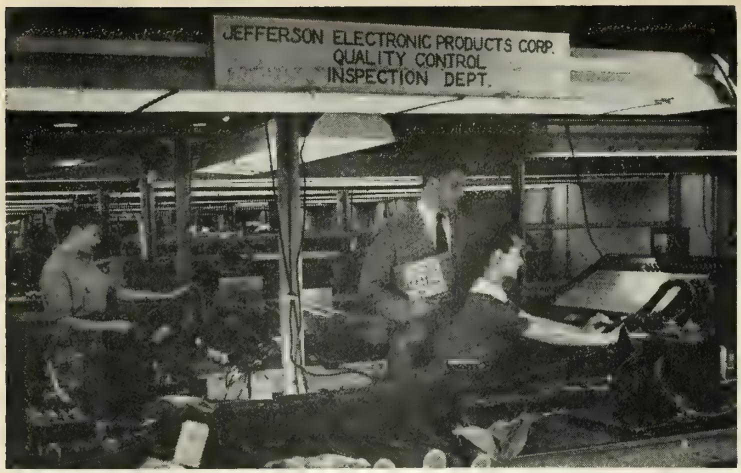
JEFFERSON ELECTRONIC PRODUCTS CORP.
QUALITY CONTROL
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MODERN TESTING METHODS Assure Product Reliability and Quality for Jefferson Electronic

DIT-MCO Circuit Analyzers Automatically Detect Finite Flaws in Highly Complex, Multiple Interconnected Circuitry

A simple, efficient system for planning, performing, controlling and recording the complete test cycle of any electronic or electrical circuitry has been developed by DIT-MCO, Inc., Kansas City, Missouri. This revolutionary concept can virtually eliminate electrical circuitry errors, both in assembly line and custom manufacturing operations. In action at the Jefferson Electronic Products Corporation, of Santa Barbara, California, it provides the exacting quality control and reliability which have helped to make the company's products famous. In addition to quality control and universal application, the system improves interdepartmental communications, facilitates coordination and provides up-to-the-minute test information at any stage of planning, production or maintenance.

This new testing system is built around the DIT-MCO Circuit Analyzer, a highly accurate, automatic circuit tester which makes rapid, sequential tests of any complex, multiple interconnected circuitry. The basic model tests up to 200 circuits in twenty seconds, and test capacity can be enlarged to any required degree by adding multiplier sections. It detects potentially dangerous, finite wiring flaws by simultaneously testing one wire against all others commoned together . . . without special connections. All external resistive devices are automatically energized and functionally tested, and circuits connected together at common terminal points are thoroughly checked. The Analyzer never requires internal modification and easily adapts to any test by use of adapter cables. The exclusive DIT-MCO Matrix Chart pinpoints error location, circuit number, type and amount of fault, enabling technicians to make corrections without reference to manuals or diagrams. Standard, telephone-type components give years of trouble-free service with minimum maintenance. Nontechnical personnel easily master operation with less than one-half hour's instruction.

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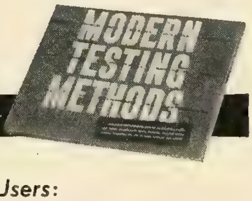

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. . . Space logistics

Following the lectures, a series of five seminars, with a general officer heading each, discussed personnel facilities, maintenance, supply and transportation implications of space planning.

"From industry," Gen. Kelley, the sponsor, said, "we have gotten a feel for the type of vehicles we will need and from the medical people we have learned some of the human factors and problems to be solved."

Lack of foresight, the General continued, frequently causes us to do many things we would not do and spend money we would not otherwise have to spend.

"The biggest asset we can have," Gen. Kelley said, "is reliable hardware which will enable us to solve the problems of trajectory, velocity, communications and guidance—a degree of reliability far beyond that which we have required thus far."

The same thought was voiced by Dr. W. R. Dornberger of Bell who said that current guidance and telemetry would not solve the problem.

"The rendezvous is the main thing," Dr. Dornberger said, "it will be a very difficult task to get the supplying vehicle in the same plane, at exactly the same speed and at the same time so that supplies and personnel can be transferred from one to the other."

Dr. Dornberger said he did not believe the Russians were putting very much effort into lunar probes, but were concentrating on getting the manned satellite.

"This would be a great achievement and have great psychological value as it would really open the door to space travel," Dornberger said, adding that he did not think this country is neglecting the man in space projects in favor of lunar probes but rather that both projects are being given emphasis.

Brig. Gen. Boushey, Director of Advanced Technology and AF Deputy Chief of Staff for Development said many might have the wrong idea about space logistics.

"We don't now envision thousands of space ships all over the place. Rather, our goal at the present is economy. That is, how to get a pay load into orbit at a minimum cost," he said.

In discussing the human factors involved, Col. C. H. Roadman, Chief of AF Human Factors Division said that while the exact dimensions of the radiation belt indicated by satellites, he did not see it as a great barrier and predicted that it might be that eventually a space pilot would get a radiation forecast in the same way today's pilots get a forecast.

Navy Confident of Meeting IRBM Schedule

With the first flight test involving operational engine components of the *Polaris* Fleet Ballistic Missile (which was put through test firing last week at Cape Canaveral), the Navy is confident that tight test schedules in the IRBM's development will be met despite a guidance failure.

The test was essentially for the Aerojet-General first and the Thiokol second stages. Flight tests using a motion simulator, already completed at the Air Force Missile Test Center, are programmed for the near future.

It has been learned that some 21 out of 22 "dummy" test vehicles thus far tested have been successful, and a number of static tests also have reportedly achieved a "high degree" of success.

British Get Swedish Order for New Missile

The Royal Swedish Airboard has placed an order with Bristol Aircraft, Ltd. for Great Britain's surface-to-air missile, *Bloodhound*. The number of missiles was not disclosed.

The 22-foot missile has been under development since 1949. Two *Thor* ramjet engines, mounted above and below the fuselage, supply sustaining power. Solid propellants boost the missile to operating speed at the rate of 1,500 fps. It uses a combination of beam and homing systems for guidance.

According to President David Proudlove of Bristol Aeroplane Company U.S.A. Inc., it is the first export order for a British-developed defense missile.

TAC Shows *White Lance*, New Air-to-Surface Missile

The Air Force's Tactical Air Command has unveiled its new White Lance air-to-surface missile.

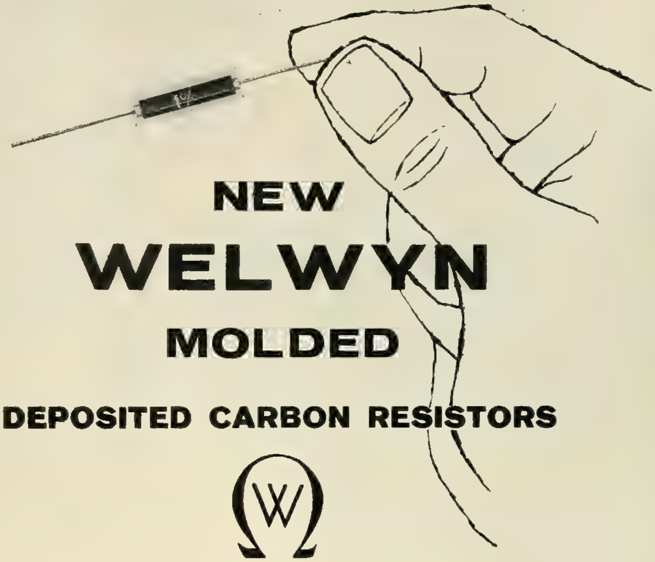
A modified version of Navy's Bullpup, White Lance incorporates changes in the propulsion system, guidance system and payload. It has the same general shape as Bullpup, and will be used by TAC in attacking ground targets.

Bomarc Replaces CF-105

Boeing's IM-99 Bomarc will become Canada's major air defense weapon, confirming a foremast made by m/r (July 28, p. 49).

Canada will cancel a planned $2-billion production program for the upersonic CF-105 *Avro Arrow*. The aircraft's flight and fire-control system (Astra), and the *Sparrow* missile, also got the economic axe.

REDUCE BREAKDOWN FAILURES



NEW WELWYN MOLDED DEPOSITED CARBON RESISTORS

The use of a thermo-plastic insulation material has resulted in an economically priced molded carbon resistor of markedly improved endurance and long term stability.

Type N resistors subjected to several one-hour cycles of immersion in boiling water — while DC polarized — have revealed only negligible changes in resistance. Continuous operations at 150°C caused no damage to the component.

The new Type N resistor, a deposited carbon film fired onto a porcelain rod, is first tropicalized with multiple coatings of panclimatic lacquers to give it long term moisture resistance, and is then molded in a thermo-plastic material.

This molded insulation has an effective resistance in the order of 10^{13} ohms. Its inherent thermal conductivity is approximately ten times that of air, resulting in substantially improved load life under conditions involving excessive or high wattage dissipation. Similarly, Type N resistors may be soldered as close to the insulation as desired without fear of melting or deforming the cover.

One added advantage of the Type N is that the original markings on the resistor body remain visible and legible through the transparent molded material.

Welwyn Type N carbon resistors meet the requirements specified by MIL-R-10509B, and are available in all values, ranging from 10 ohms through 1 megohm. For complete data and specifications write to Welwyn International, Inc., 3355 Edgecliff Terrace, Cleveland 11, Ohio.

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Job for Electronics: Weighing Big Missiles

Center-of-gravity determination—one key to missile reliability—makes use of special techniques to insure distribution of weight.

Among many critical and complex techniques used to increase and assure the reliability of ballistic missiles is a technique utilized by Chrysler Missile Division engineers for determining the exact center of gravity of each missile.

The center of gravity is a key element in missile design, and greatly affects the flight path or trajectory of a missile during flight.

Basically, the center of gravity of a ballistic missile is determined by weighing each component and electronically weighing assemblies and sections of the missile, as well as the entire completed missile.

The center of gravity is extremely critical in relation to the top or body section. At the point of trajectory where burn-out occurs, the body is separated from the thrust section. This separation must occur with minimum disturbance to permit the body to continue in the predetermined trajectory.

The Structural Design Department at Chrysler Missile Division calculates the predicted weight and center of gravity for each missile. To insure proper balance, they receive information on the actual weight of each component as it is installed in the missile, and check actual weight against predetermined weight calculations. It is essential, in confirming the exact center of gravity, that the weight of each component or unit placed in the missile stays within established weight tolerances.

The problem of accurately weighing large and heavy missile sections and entire missiles has been solved with a servo null-balance instrumentation system designed and built by Performance Measurements Co., Detroit, Michigan.

• **Weighing the missile**—When all components are installed in the missile, the resultant center of gravity location is determined by the electronic weighing system with a digital readout. The missile is suspended by two cables. A strain gage load cell is attached in series with each cable between the missile and an overhead crane. Each cell has a 10,000 pound capacity.

During the weighing operation, the missile fule tanks are filled to simulate actual weight distribution during a flight. Before the cables are attached to the missile, the load cell system is balanced to read zero; this excludes the weight of the cable, yoke and shackles from the final weight reading. Then the cables are attached to lifting stations or suspension points which are designed into the missile. The missile can then be lifted into the air by the crane.

Suspension points on the missile are located during the manufacturing operation to a tolerance of 0.030 inch for each point. Exact placement of the lifting stations is of course essential in determining weight distribution.

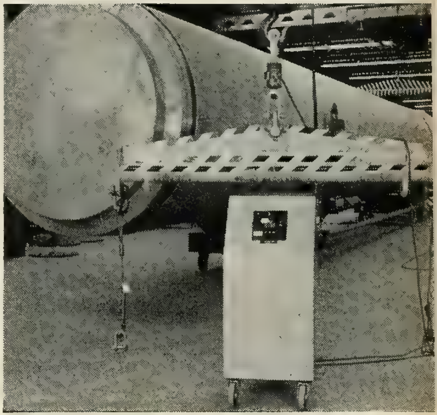
• **Weighing instrumentation**—As shown in the block diagram of the weighing system, the digital indicator consists of a measuring circuit, an electronic amplifier, precision slide wire, and a servo balancing motor.

An excitation voltage is placed across each of the load cells, the strain gage bridges within them become unbalanced. This unbalance is translated electronically into an indicator reading calibrated directly in pounds.

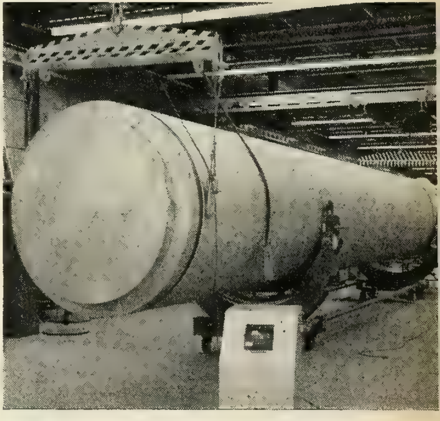
The heart of the weighing system is the servo null-balance indicator with digital readout, developed by Performance Measurements Co. The performance measurement team responsible for the project was headed by Donald Courtney. The servo-null-balance portion of the instrumentation incorporates a precision slidewire (infinite resolution potentiometer) in a bridge circuit. This potentiometer has a linearity of 0.025%. The entire system allows 0.1% of full scale accuracy in weight measurements.

The internal slidewire is the major component of the internal bridge. The amplifier compares the unbalance of the load cell bridge with the voltage across the internal bridge. Any difference in these two signals is chopped and amplified.

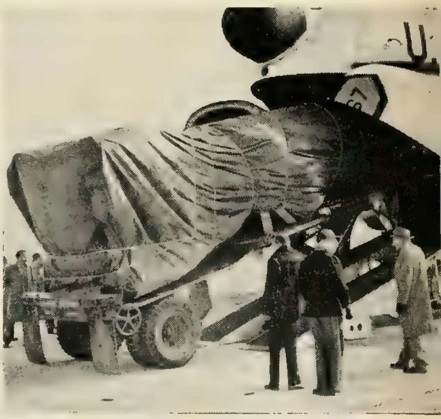
This signal then energizes the servo balancing motor, causing it to turn the potentiometer in the direction for a balanced null. Number wheels are geared directly to the slidewire shaft,



READY for weighing operation, yoke and null-balanced servo are set up.



HELD IN YOKE, missile registers full weight on servo from two points.



AIR TRANSPORT of missile is another reason for determining center of gravity.

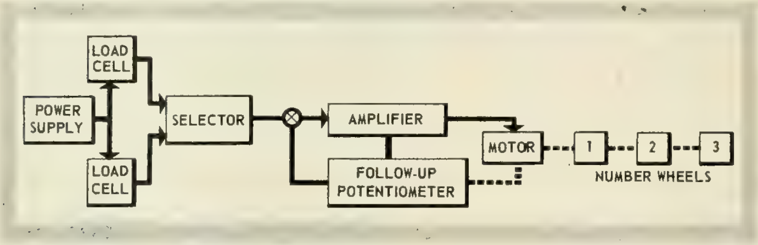
so that the digital readout has a constant relationship to the slidewire position.

Both the load cell and internal bridge circuit are supplied from the same voltage source, so that line variations do not affect accuracy of readings. In fact, this circuit arrangement allows up to ± 50% variation in bridge supply voltage with no change in zero or span.

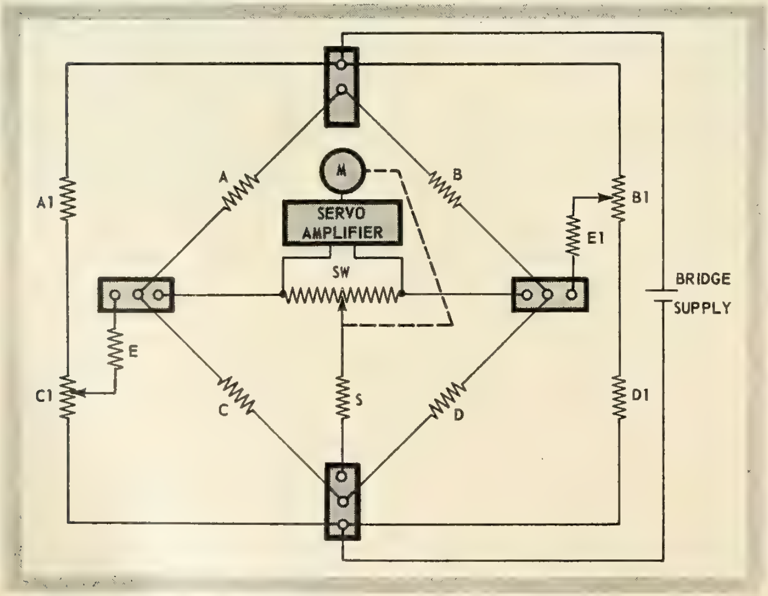
To actually determine the center of gravity, calculations are made on the basis of both the total recorded weight of the entire missile and the individual weight readings taken from each load cell. A channel selector on the instrument allows the engineer to take readings from each load cell individually; only one digital indicator is needed.

Electronic weight determination of components or finished missiles provides highly accurate weight data for aeroballistic purposes. This is one of the techniques used to prove theoretical calculations and reduce the margin for error complex processes involves in the building of successful missiles.

The increasing need to transport missiles by air is another pressing reason for accurate weighing, since stability of the load as well as relationship of load to lifting capacity of the carrier, is of course a matter of major concern.



OUTPUT of bridge-type strain gage load cell pickup feeds to input of digital indicator, in this block diagram. Indicator is servo null balance type, equipped with an electronic amplifier, multiple-turn tapped precision slide wire and servo balancing motor. Motor drives number wheels for digital readout.



IN OPERATION, a load or unbalanced signal in the external bridge causes a current through the slidewire (SW), which is translated as an error voltage, then the motor rebalances the error, the amount of unbalance being read as load. A,B,C,D are load cells in external bridge; A_1,B_1,C_1,D_1 are located inside the indicator. E, E_1 are resistors which isolate the balanced zero control (C_1 and B_1) from the external bridge. Resistor S determines amount of unbalance, or span, permitted.

13 New Members Admitted to EIA

Thirteen additional firms have been accepted for membership in the Electronic Industries Association by action of the Board of Directors during the Association's three-day fall conference in San Francisco, Sept. 16-18.

The action of the Board was based on recommendations of the various EIA divisions involved. The firms are:

Aeronutronic Systems, Inc., 1234 Airway, Glendale 1, Calif.

Amco Engineering Co., 7333 W. Ainslie St., Chicago 32, Ill.

Columbus Electronics Corp., Semiconductor Div., 1010 Saw Mill River Rd., Yonkers, N. Y.

Continental Illinois National Bank & Trust Co. of Chicago, 231 South LaSalle St., Chicago, Ill. (Associate Member).

The Martin Co., Baltimore 3, Md.

Master Mobile Mounts, Inc., 1306 Bond St., Los Angeles 15, Calif.

Resitron Laboratories, Inc., 2908 Nebraska Ave., Santa Monica, Calif.

The Siegler Corp., 610 S. Harvard Blvd., Los Angeles, Calif.

SNC Manufacturing Co., Inc., P. O. Box 277, Oshkosh, Wisc.

Syncro Corp., Electronics Div., Meusse Argonne Ave., Hicksville, Ohio.

U. S. Semiconductor Products, Inc., 3536 West Osborn Rd., Phoenix, Ariz.

United Transformer Corp., 150 Varick St., New York 13, N. Y.

Wyco Metal Products, 6918 Beck Ave., North Hollywood, Calif.

Litton Industries Purchased by Westrex

Announcement was made recently of the purchase of Westrex Corporation by Litton Industries, Inc. Purchase price of Westrex, formerly a wholly-owned subsidiary of Western Electric Company, was not disclosed.

Westrex foreign offices are commencing distribution of Litton communication equipment, radar antennas, instrument landing systems, and medical x-ray units.

Upon the completion of the transfer of ownership, Westrex now handles tropospheric and ionospheric scatter relay equipment for over-the-horizon communication and a new line of communication and power wire and cable. Westrex, a Delaware corporation, operates 19 foreign sales, service, and distributing subsidiaries. The company employs more than 1200 persons, 1000 of which are overseas. An assembly plant is maintained in England. Gross income for 1957 was more than $13 million.

Contractors Selected For $60 Million Navy Project

Navy has identified the successful applicant for the prime contract to construct the giant $60 million Naval Radio Research Station at Sugar Grove, West Virginia. Selected as a joint venture for the prime contract from a list of about 125 firms, were three contractors representing three states—Virginia, Pennsylvania and Nebraska. The three firms of the joint venture are Tidewater Construction Corporation, Norfolk; Peter Kiewit Sons, Omaha; and Patterson-Emerson-Comstock Incorporated, Pittsburgh.

The project involves the fabrication and erection of a giant steerable radio telescope to be used in studies of outer space, advanced scientific research on characteristics of the earth's atmosphere, and geodetic and geomagnetic studies of the earth.

It is anticipated that major construction work will commence no later than October 15, 1958. Bids have already been solicited from subcontractors for preliminary ground work.

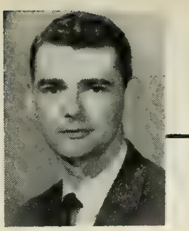
Final selection for the prime contract was made by a special contract selection board appointed by Rear Admiral E. J. Peltier, Chief of the Navy's Bureau of Yards and Docks, from a list of 10 best qualified firms which were carefully screened from the larger list. The Bureau of Yards and Docks will administer the project for the Navy through the District Public Works Office, Fifth Naval District, Norfolk, Virginia.

Newest *Falcon* Shown, Has Greater Speed, Range

DALLAS—Existence of new supersonic air-to-air guided missile that is said to climb higher, fly faster and have a greater range than any of its predecessors, has been announced by the Air Force and Hughes Aircraft Company, developer and producer.

Fourth in the family of *Falcon* missiles produced by Hughes for the Air Force, the new GAR-3 (guided air rocket) is scheduled to go into operational service soon as principal firepower for advanced all-weather jet interceptors.

Roy E. Wendahl, vice-president and manager of Hughes' airborne systems group, described the newest *Falcon* as "a semi-active radar seeker type, incorporating advanced engineering and manufacturing techniques."



astrionics

by Raymond M. Nolan

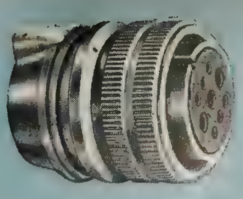
Communications from space vehicles were given a boost recently with the announcement by the University of Michigan of its ruby maser—capable of outperforming both vacuum tubes and transistors. In the ruby maser system, the ruby is placed in a magnetic field and immersed in liquid helium. The magnetic field aligns the electrons of the ruby's atoms while the frigid helium reduces noise due to atomic motion. Electrical energy is supplied to the ruby's electrons so that an incoming radio signal can trigger its release and produce a large signal output. U-M researchers see eventual production units in packages no larger than a filing cabinet.

Major procurement and production contracts placed by the Defense Department in FY 1958 totalled $16 plus. Of this amount, electronics and communications totalled a little more than $1 billion. The figures do not include programs budgeted with research and development funds or production equipment obligations to support aircraft, missiles or electronics equipment.

DOFL (Diamond Ordnance Fuze Laboratory) recently celebrated its 5th anniversary with an open house. Among the exhibits was a first showing of the micro-miniaturization techniques developed by DOFL and felt by many to be the foremost in the country. Some future items will be digital modules about the size of a five cent piece and several times as thick. The electronics components will be embedded in ceramic and will be capable of being stacked in almost any configuration. Another DOFL item of interest is its short-pulse radar, developed in conjunction with a proximity fuzing device. Said to be as close to unjammable as you can get with radar.

The new missile *"White Lance"* to be employed by the Tactical Air Command is reported to be a *Bullpup* with improved guidance, a new propulsion system and a "different" warhead. No details are known about the propulsion system, but the improved guidance is probably the television guidance that Martin has been trying on versions of the *Bullpup*. TV guidance was tried during WW II but was not very successful because of vehicle preturbations which disturbed the picture. The system now being tested reported has solved this problem and gives a stable TV image so that the pilot, who controls the missile from the airplane, can achieve positive control even when *White Lance* is out of visual range. The different warhead can only mean a nuclear one since present versions of the *Bullpup* use high explosive. (See also p. 21).

A recent achievement of the National Bureau of Standards was the free precession determination of the proton gyromagnetic ratio. Importance of this will be felt by many research projects since it means that the proton can now be used as a very sensitive probe to determine magnetic intensity in terms of the precisely known gyromagnetic ratio. Specific applications will range from cyclotrons and mass spectrographs to servo mechanisms and electromagnets. The NBS work is part of a broad scale program which seeks to obtain more accurate values for constants such as the velocity of light, the acceleration of gravity, and the various atomic constants. Like other atomis nuclei, the proton, or hydrogen nucleus, behaves as a small magnet. When placed in a magnetic field, it tends to orient its axis along the direction of the field. But, because the proton is spinning itself, it acts somewhat like a gyroscope and precesses about the field direction. The ratio of the angular precession frequency to the magnetic field strength gives the gyromagnetic ratio.



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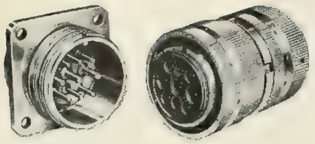

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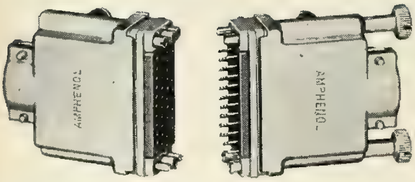

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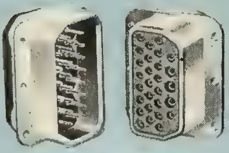

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Scope Inc., New R&D Company Organized

Announcement was made recently of the formation of a new company, Scope Inc., by several former employees of Melpar Inc.

Scope was originally the Wilbespan Research Labs, but activities were then on a smaller scale. The new company intends to direct its work in the research and development field in the physical sciences. It is located in Fairfax, Virginia.

Co-founders of Scope Inc. are Richard E. Williams and Johnathan J. Broome, both formerly with Melpar. Mr. Williams was assistant to the VP for Research and Engineering, and Mr. Broome was assistant to the Executive VP.

Navy Scientists Hear Report On Missile Guidance Filters

Properties of infrared interference filters used in the guidance systems of missiles and rockets were recently reported by Kodak scientist Paul B. Mauer at a Naval Research sponsored meeting on infrared information in Boston.

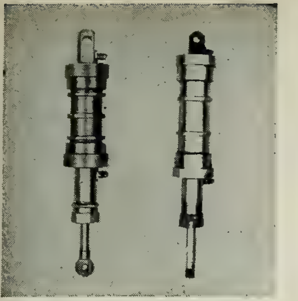
Mauer reported the characteristics of various filter types used to screen out unwanted wavelengths of infrared energy. This property makes the filters of great value in a missile guidance system because they can discriminate between the radiation coming from a target and energy coming from the sun or the target background.

Mauer's talk included comparisons of various filter materials and graphs of their transmission properties under differing conditions. He also showed ways in which filters can be out or combined to give desirable transmittance characteristics.

EIA Opens New Standards Laboratory

A standards laboratory to perform test measurements for tube and semiconductor manufacturers has been placed in operation by the Electronics Industries Association.

The long-established laboratory, located in Newark, N.J., formerly was operated at the same address for receiving and cathode ray tube manufacturers as a part of the RCA Industry Service Laboratory. EIA tube manufacturers have combined this with a similar operation of semi-conductor manufacturers which had been conducted at Syracuse University. Availability for use by the Armed Services is planned for the future.



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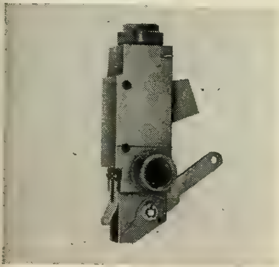

CONTROL VALVE: 5000 psi, manual. Controls air flow to actuating components from supply source. Can be actuated directly by hand, cable pull, or other manual means.

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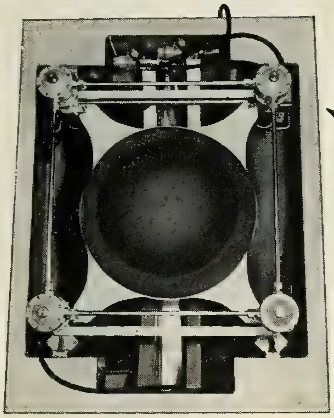
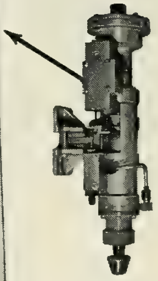


Vibration Isolation System



Vibration Isolator

Newest Kidde development: The Pneumatic Vibration Isolation System. Employing relatively inexpensive components, it maintains desired low natural frequency and reduces the relative displacement at various load conditions.

The system shown above is one of several Kidde pneumatic vibration isolation system programs for protecting delicate missile control systems from undesirable vibratory disturbances and great transients in "g" loading which would affect accuracy of control. The component in the inset photo incorporates the system's mechanical and air snubbers, air spring, servo valve and passive isolator.

Research on projects like this new vibration isolation system goes on constantly in Kidde's vast creative pneumatics engineering department. For more information on any Kidde components, or help in solving specific pneumatics problems, write or call Kidde today.

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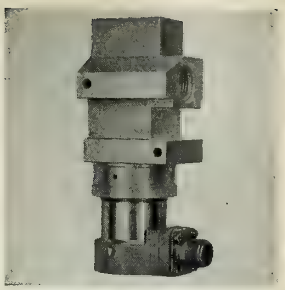

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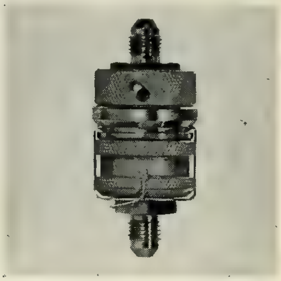
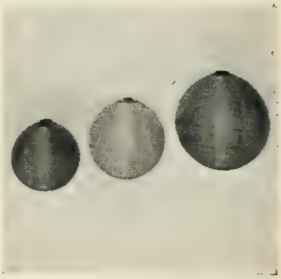


QUICK DISCONNECT: Double-check — permits fast coupling or uncoupling of components without pressure loss. Has pressure check in both inlet and outlet unit.



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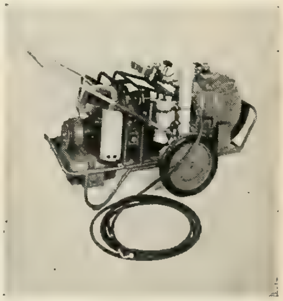

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Hughes Aircraft Gets $30 Million Contract

The U.S. Army Signal Corps has awarded a $30,689,713 contract to Hughes Aircraft Co. for production of elements of "Missile Monitor" air defense systems for use by a field army.

Designated AN/MSQ-18 by the Signal Corps, the system is the operations control center at battalion level for overall mobile defense operation attached to an army in the field.

MSQ-18 systems will tie in and coordinate airborne target information from existing U.S. Army radar to existing missile batteries. It will insure maximum efficiency and employment of such Army antiaircraft units as the *Nike* and the *Hawk*.

Production will take place at Hughes' Fullerton, Calif., plant. The contract will involve a monthly payroll of $800,000 at Hughes; $125,000 monthly external purchases in the Los Angeles area; and employment of approximately 1,600 people at maximum production. An additional 250 employees working for sub-contractors will participate.

GE Shows "Plasma Accelerator" Control

Further progress in the plasma jet field was indicated at the Air Force Association Convention in Dallas, when General Electric unveiled a working model of what it calls a "pulsed plasma accelerator." The accelerator can be used to control the direction of space craft in their flights through space. (See m/r Sept. 29, p. 11.)

The accelerator, which is one of several types being developed by GE, was built by GE's Aerosciences Laboratory in Philadelphia. It uses the magnetohydrodynamic principle to propel a low density gas at high specific impulses.

Inside a T-shaped glass tube, with its normally horizontal cross-arm in a vertical position and the vertical arm extending into an evacuated chamber, a plasma is formed and discharged into the chamber.

The plasma, composed of ionized gas, is produced by a hot electric field generated by regularly occurring sparks between brass electrodes. The current is returned through a brass strap outside the glass tube, setting up a magnetic field to help propel the plasma out the tube into the chamber.

The evacuated chamber, designed to approximate the vacuum conditions of outer space, is made in a bell jar.

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Circuit Development
Group Leader Ralph Wolcott
(left) considers future changes
in computer output unit for
bombing—navigational systems.

Ground-floor
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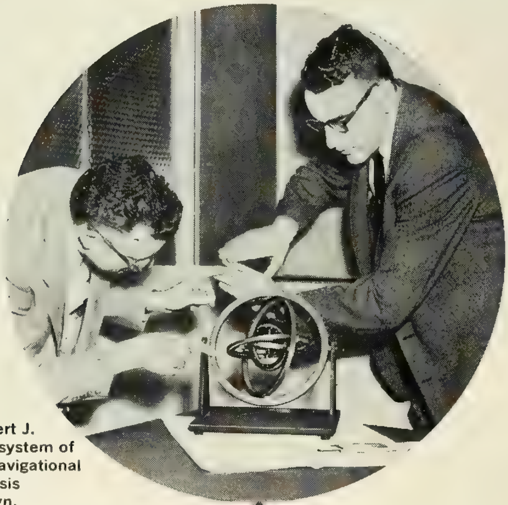

Project Engineer Robert J. Cantwell (left) uses a system of gimbals to describe navigational problems in the analysis of a new system design.

Staff Engineer William Howard (center) reviews gearing accuracy requirements of test equipment with electronic circuit designers.

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Space Team Must Include Skills of Basic Sciences

U.S. efforts will need top brains to meet challenge posed by non-military vehicles

by L. Eugene Root

L. Eugene Root, a nationally recognized missile scientist, heads the Development Planning Dept. of Lockheed Missile Systems Division. Root's group advises management on directions of development, trends in power and utilization of scientific advances in various fields. The following article was presented at a recent meeting of the Northern California Branch of the American Astronautical Society.

The development of astronautics, carried along on the back of the guided missile, makes a good story: the German pioneers of the Interplanetary Society struggling along with their small-scale experiments, until they were picked up by the German Defense Ministry and deposited in Peenemunde with the vast resources that perfected the V2 missile—but still dreaming of the conquest of space.

Then the sequel, after World War II, when the national and technical resources of the U.S. were brought into the further development of the ballistic missile; providing the powerful engines, the guidance techniques and hypersonic know-how with which the exploration of space could finally be started.

There is a third chapter which tells how Russian ballistic missile development followed the same course, arrived at an orbiting capability at about the same time, and turned the pioneering exploration of space into a kind of gold rush, 1957 version.

Let us now examine the part industry should play in the next few years, now that astronautics has become an important technology in its own right.

Evidently, we are now past the ime when astronautics made progress only by the fortuitous coincidence with ballistic missile development; in fact, here are many of us who now anticipate a divergence between the future paths of development of the ballistic missile and the space vehicle.

In particular, the differences arise mainly from the small size of the earth and the large size of the universe. On the earth, for example, there are no radio communications circuits which are expected to work over distances longer than about 5,000 miles; a radio communications circuit, even to a moon vehicle, would involve distances 50 times greater. Thus, taking into account the inverse-square law, the difficulty of radio communication is increased by about three orders of magnitude.

For planetary distances, the problems concerned become even more impressive. For journeys outside the solar system (supposing we knew how to make them) we should find ourselves in a totally new regime.

• **Military objectives limited**—Again, considering the minuteness of the earth and the vastness of outer space, we find that the requirements on military missile performance are strictly limited by the short range of the longest significant mission.

A military missile is required only to propel itself from one point on the surface of the earth to another. Taking the long way around, this involves a 20,000-mile journey, all of which is accomplished in a strong gravitational field and in a dense atmosphere. Under these circumstances, the requirements for propulsive devices involve high thrust for short periods of time.

For the long missions of space travel, engines of very low thrust but high specific impulse may well turn out to be most useful. There is presently no known economically feasible way to design and develop such engines, even though military use can well be visualized.

The same general remarks apply to other important fields of technology; to guidance, to navigation. They apply to the developments necessary to enable men to live in the new and largely unknown environment of space, outside of the protective envelope of the atmospheric ocean.

• **Still exploratory**—During these years astronautics will be almost certainly in the exploratory stage. We shall be learning how to live, how to adapt ourselves, our instruments, and our habits and customs, to the new environment. When we talk of the exploration of space we imply exactly the same kind of adventure that has stimulated all exploration—the challenge of the unknown. It is of course this challenge which explains the tremendous current popular interest in astronautics.

Ever since the disappearance of our Western frontier, we have looked for some substitute for the old adage "Go West, young man." And here it is, in the conquest of space, an unprecedented technical challenge with overtones of international rivalry.

Even at ground level, the pattern of exploration has been changing greatly during the last few years. The individual explorer, who vanished for ten years into the wilderness and came back with fabulous tales, has now gone forever.

If you look at our recent attempts upon the last remaining frontiers on earth—for example, at the present South Polar expeditions involving the military, scientific programs, private industry and individual specialists; or the conquest of Everest by Hillary's team—you will realize that exploration is now a concerted team effort, rather than a matter of individual and personal accomplishment. This is an indication of the obvious fact that modern techniques for exploration now demand more skills, more specialized knowledge and

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abilities than we can expect to find, by any standards in any single individual.

• **Team job**—Modern exploration requires a team—and the care with which the team is selected, their original competence and their effective training, and the smoothness with which their individual contributions can be meshed together, are the things which determine the success in attaining the goal. The functions of organization, of guiding the team effort so that every member is contributing his maximum, are all-important.

It is important to emphasize here that the growth of the explorer team has not reduced in any way the requirement for intense individual effort from the team member. Nor should it diminish the personal incentives, or the sense of individual accomplishment, which every member of the team must be able to feel when the goal is reached.

• **Industry role**—The role of industry in the exploration of space is now very evident. More than any other mission upon which we are now engaged, the development of space flight will require team effort during the exploratory stages that must be completed in the next few years.

The groups which the missile industry has assembled are of course the most obvious source for such a team; and in particular, the industrial teams which have, during the past three or four years, developed the rocket-propelled ballistic missile appear to combine many of the special skills which are critical in the exploration of outer space.

When I talk about an industrial team in this way, I am not referring only to the accumulation of specialists within the organization of a prime missile system contractor. I am including also the complete system of links which we have forged, by personal contact, or by subcontract, which permit us to draw upon the whole resources of our government research laboratories and our industrial specialists throughout the country.

• **Special skills**—What are the specialist skills which should be gathered together in such a team, to permit it to advance most rapidly in the exploration of space? Dr. von Karman has discussed this question quite recently. In a recent address to the AIA, he stressed the fact that the "foundation" sciences of aeronautics—the mathematics, physics and chemistry underlying our rapid advances in airplane structures, propulsion and dynamics—are still the major contributors to flight in space and successful return to the earth.

Problems of navigation, of conditioning of the environment, particularly for the human occupant, represent considerable extensions of our developments for airborne vehicles; but they *are* extensions, it must be remembered—not fresh starts.

Dr. von Karman's speech was, in fact, a request to apply to space flight all the know-how which we have accumulated in our present more restricted flight, and not to shoot off enthusiastically re-discovering things in all directions (as we occasionally have a habit of doing!).

An even more important question is: what does our individual team of explorers currently lack which might jeopardize the success of the mission? In reply to this question, I'm not going to say "We have it all." We don't! Many of the answers we want can only come from a good astronautical research and development program; and we cannot expect to make up the deficiencies of years of inadequate effort by a sudden spurt, lasting only a few months.

- **Information needed**—Even now, after all the clamor throughout the country for accelerated space research, we are getting back from space only a small fraction of the environmental information which our competitors are obtaining from *Sputnik* III. We *must* put more effort on getting back data from space, so that we can find the answers.

We are also lacking in research facilities. As an example, we has been working for some time in the problems presented by space structure; structures which have to carry no weight and yet need cope with no aerodynamic drag.

The most efficient constructions for these conditions are light and thin; they may not even support their own weight on the ground. How do we check out such structures on the ground before putting them into orbit? There does not exist at present any facility which would enable us to do this; and what is worse, there are very few ideas about how to make such a facility.

It is quite possible that the next research laboratory to be built by the U.S. government will be on an elongated elliptical orbit. I'm sure that there are many who would be very willing to participate in the building of this laboratory. ★

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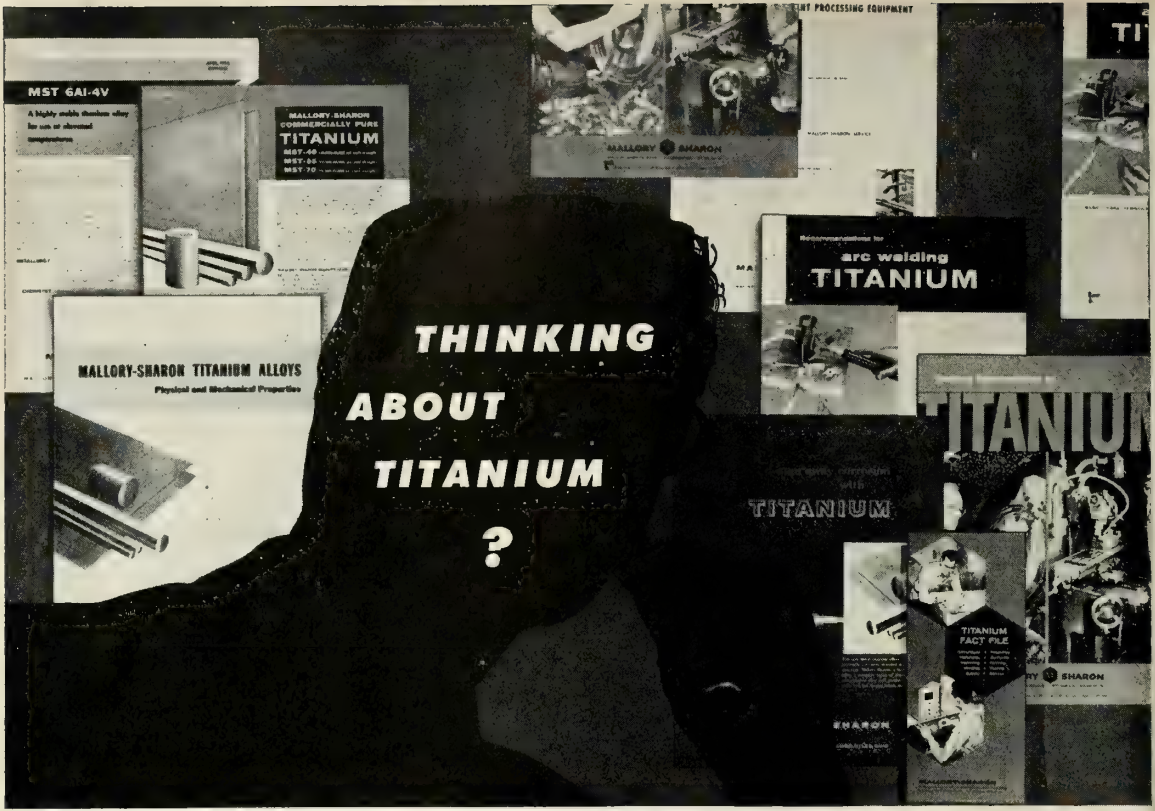

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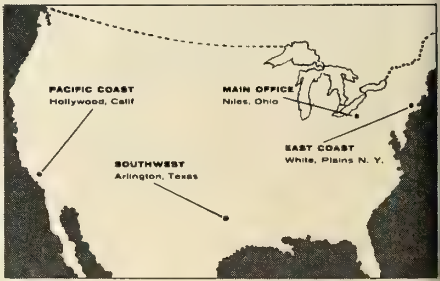

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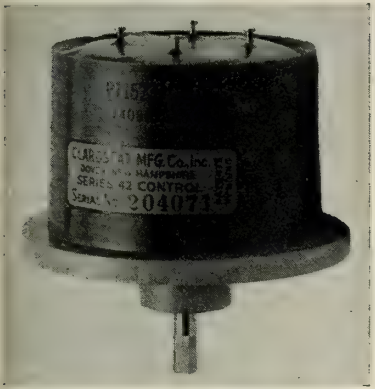

A sine/cosine potentiometer for use in radar, computer and servo-mechanism assemblies is now available from **Clarostat Mfg. Co., Inc.,** Dover, New Hampshire. The new unit has a standard conformity of plus/minus 1% peak-to-peak, or a special conformity of plus/minus ½% peak-to-peak.

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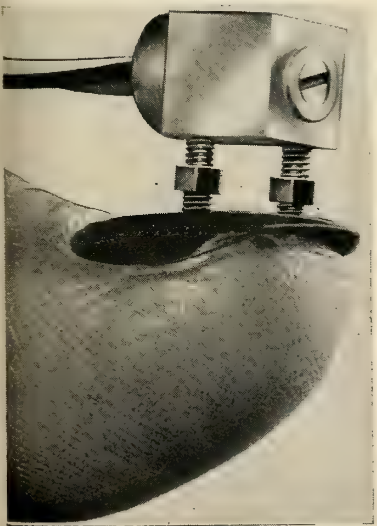
Trimmer Potentiometer Designed For Extremes



Designed for horizontal-mounting applications, these trimmer potentiometers which measure only ¼ inch square by 3/8 inches long are engineered and tested for operation under environmental extremes of heat, cold, humidity, vibration and shock.

Available for stud-mounting (Model MS-4) and lead-mounting (Model MS-5) on printed wiring boards, both models feature low temperature-coefficient resistance wire, precious metal wiper, Mylar and Teflon insulation.

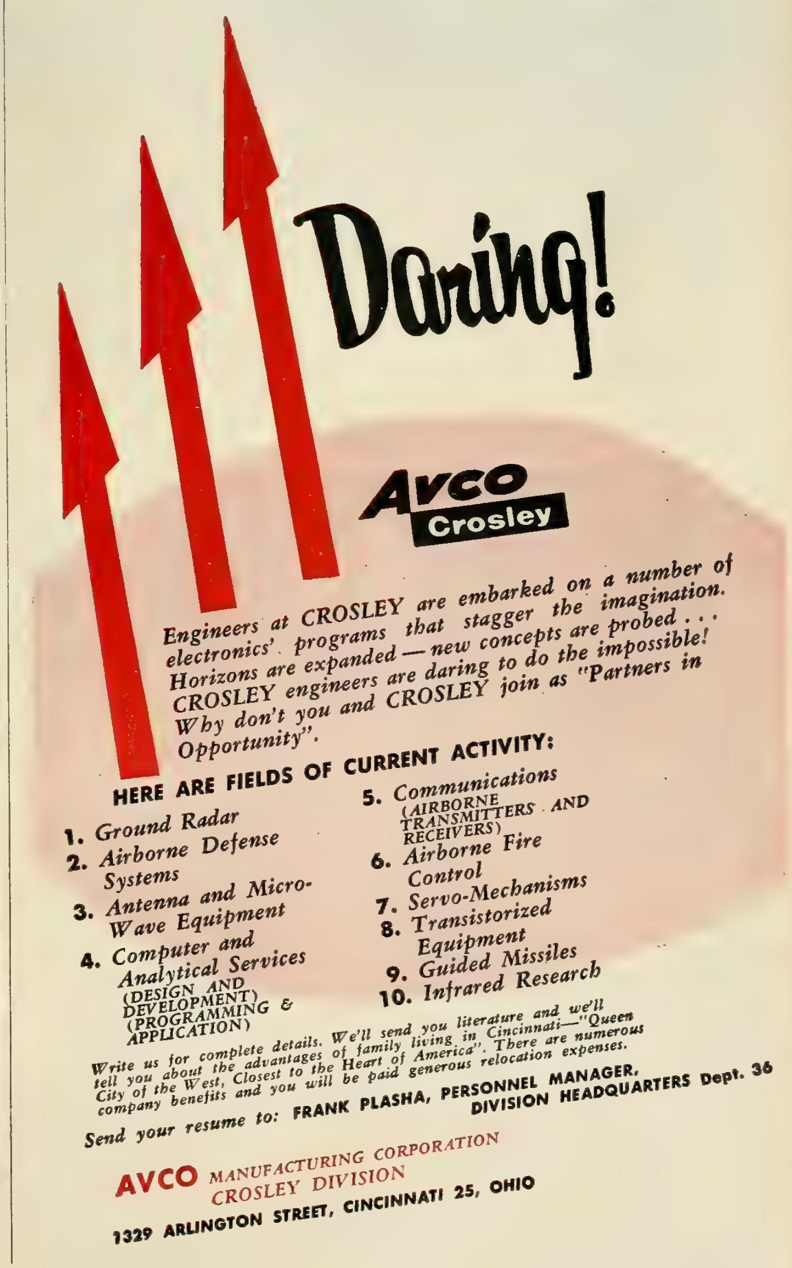
The units, developed by **Miniature Electronic Components Corp.,** are rated at ¼ watt and are available in standard resistance values from 100 ohms to 10,000 ohms.

Circle No. 226 on Subscriber Service Card.

Transistorized Chopper Designed as Modulator

Model 60 transistorized nonmechanical chopper, announced by **Solid State Electronics Co.,** Van Nuys, California, features small size, ¼" dia. x ½" long, and is encapsulated to withstand shocks of 2,000g for 11 msec, vibrations of 30g up to 2000 cps and acceleration of 5,000g.

It is designed for use either as a



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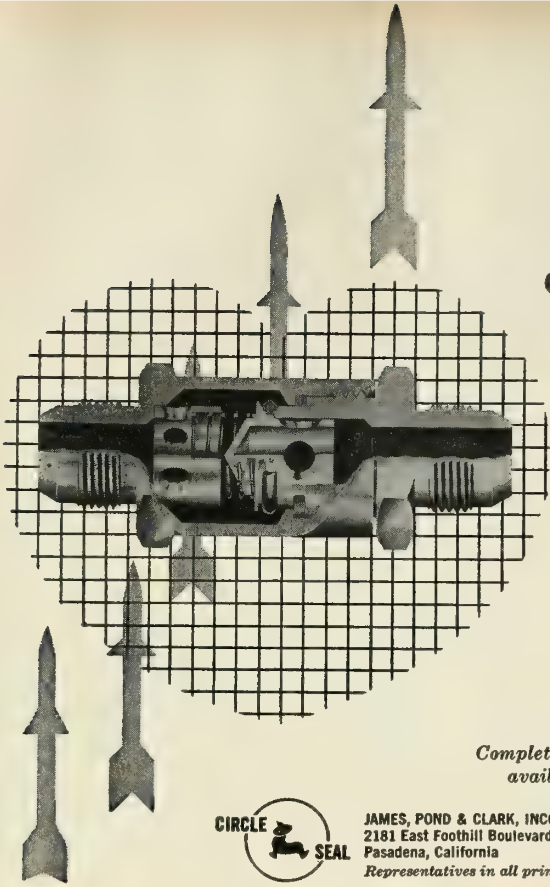

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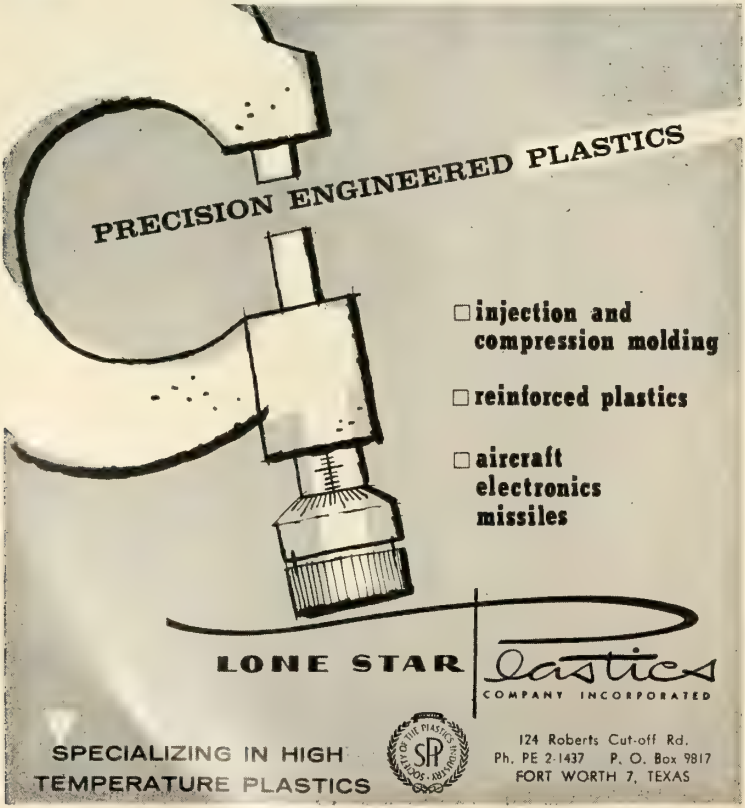

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modulator or a demodulator and being an inertialess device it can be driven from d.c. to hundreds of kilocycles, symetrically, nonsymetrically or randomly. The switching circuitry provides stability and freedom from drift over a wide temperature range, –40°C to +80°C. Weight is one gram.

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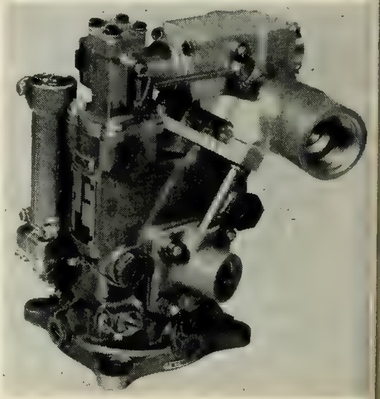
Variable-Delivery Pump Halts Turbine Stall



A variable delivery pump incorporating torque-limiting features has been announced by **Vickers Inc.,** Detroit, a division of Sperry Rand Corporation. The pump was designed for emergency ram air hydraulic and alternator drive applications. It prevents turbine stall due to pump torque requirements at start and at low air speeds.

The pump produces full outlet pressure (3,000 psi) at all turbine speeds and pump torque demand always remains within the turbine's capacity to supply torque. These conditions are met by limiting the pump's yoke position and flow rate during low rpm operation. To meet high flow requirements during low turbine speed the pump automatically adjusts to permit increased flow at reduced system pressure.

Circle No. 228 on Subscriber Service Card.

Cathode—Ray Oscilloscope Retains Pictured Images

A new cathode-ray tube oscilloscope, with a special screen phospho that records and retains a picture fo days, has been introduced by the Industrial Products Division of **International Telephone and Telegraph Corporation.**

The new instrument, called th "Storascope", was demonstrated for th first time recently at ITT's exhibit at the WESCON show in Los Angeles.

The "Storascope" is designed for recording transient pulses, and signals recurring regularly or irregularly at frequencies up to 10 kilocycles. Although the picture will remain visible for days, it may be erased in 20 seconds and the screen is immediately ready for new recordings after the erasure. Through the use of an automatic line-switching arrangement, the 3½″ x 5″ screen will record either enlarged single traces or ten traces in succession on ten separate lines.

The instrument is 11″ wide, 15⅜″ high, and 19¾″ deep. It weighs 44 lb.; has a separate power supply measuring 6⅜″ wide, 11″ high, and 13″ deep. The supply weighs 25 lbs.

Circle No. 229 on Subscriber Service Card.

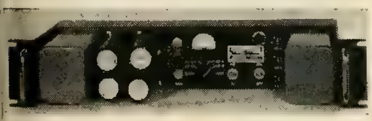
Fasterner and Bushing Offers Lowered Cost

A compression-type fastening is designed to affix or hold tubing, pipe, cable, or wire firmly immovable and also to fasten it to a panel or wall. The Barr Bolt is called less expensive than conventional approaches to this problem, and is developed by **Barr Machine and Tool Division,** Denver Metals and Chemicals Corp.

A threaded hollow bolt, which may be serrated inside for greater gripping action, features an elevated key. The tubing or cable is inserted through the Barr Bushing. The Bushing is inserted through the panel or wall to which the tubing or cable is to be attached. When the nut, which will hold the assembly to the panel, is screwed on, it depresses the key, causing compressive action on the tube or cable, holding the tube in place. At the same time, the nut affixes the assembly to the panel. Adjustment of the throw will give load pressures of any desired compressive force, according to the manufacturer.

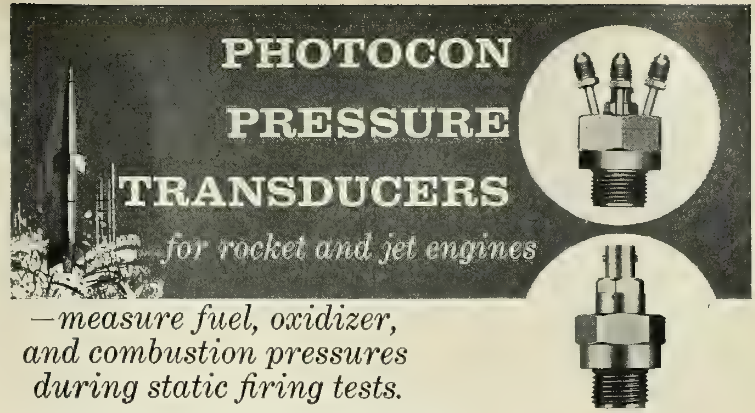
Circle No. 230 on Subscriber Service Card.

Timing Signal Amplifier For Data Transmission



Nems-Clarke Co., Silver Spring, Md. announces the availability of its Type TSA-100 Timing Signal Amplifier, designed for distribution service in data transmission systems.

This is a fully transistorized, wide brandwidth power amplifier having fre-



—measure fuel, oxidizer, and combustion pressures during static firing tests.

High freqency response—units measure static and dynamic pressures over a frequency range of 0-10,000 cps and higher. Pressure ranges: 0-5 psig to 0-100,00 psig.

Easy to install...simple to use. Only three dial adjustments required.

Capacitance gauge principle eliminates contacts and linkages. Low diaphragm mass...high diaphragm resonant frequencies.

Rugged—units insensitive to vibration and shock. Water-cooled models withstand combustion temperatures to 6000°F.

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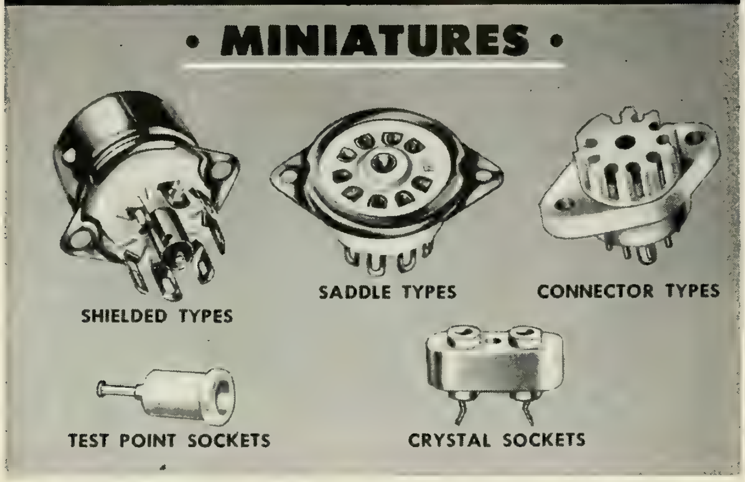

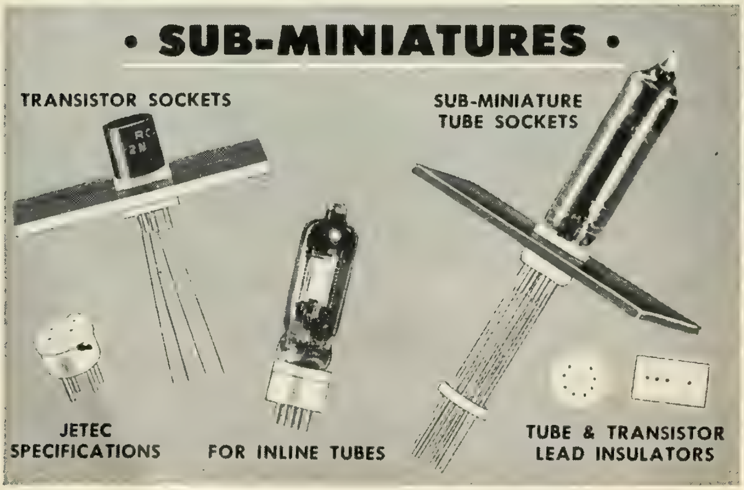

Complete variety in standard and assembly-cost saving compression mounting types. TEFLON insulated, with all metal parts and finish to JAN specifications. High reliability factor—withstand mechanical shock, vibration, high temperatures. Low loss insulating qualities, zero moisture absorption. Non-tracking arc resistance. Non-DC plating. Great weight savings (sub-miniature tube socket, for instance, weighs only .04 oz.). Catalog EC-358. Fluorocarbon Products, Inc., Division of United States Gasket Co., Camden 1, N. J.

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Fluorocarbon Products Inc.

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quency response from dc to 50 kc at full output of 5 watts, peak. At reduced power output the response extends from dc to 180 kc.

This wide frequency coverage can provide for the re-establishment of signal and power levels of a wide variety of pulse and analog data signals. The unit accepts either balanced or unbalanced inputs and amplifies these signals to deliver 5 watts into a 150-ohm balanced load. The power supply for the unit is self-contained. The amplifier occupies 3½ inches of rack space.

Circle No. 231 on Subscriber Service Card.

Microminiature Switch Has Twelve Positions

A microminiature 12-position switch with positive interlock and low rf loss for switching from DC to hundreds of megacycles has been announced by **Avion division, ACF Industries, Inc.,** 11 Park Place, Paramus, N. J.

Contact points are gold plated, with an ungrounded isolated center shaft and flush mount for control space. It is designed for any purpose, including meter, band and function switching or sub-miniature ground or airborne radio frequency systems.

Circle No. 232 on Subscriber Service Card.

Transistors Protected Against Interference

Development of a new instrument designed to protect transistor circuits from high-voltage transients, is announced today by the **Engineered Magnetics division** of Gulton Industries, Inc.

The transient eliminators are being produced in two models, EM 446 for

NEW PRESSURE TRANSDUCER: LOW VIBRATION ERROR AT 2000 CPS, 35G

Combine this with 0.17% resolution and you have truly remarkable performance. What's more, this new Model 717 Absolute Pressure Transducer is *in volume production* in ranges up to 4,000 psia. Simplicity is the keynote—an entirely new type of Bourdon tube instrument eliminates linkage systems. There is only one moving part in the unit, and static friction is less than resolution. Over-all result: excellent performance during high vibration—static error band of ±0.8% (linearity, hysteresis and repeatability).

New concepts in basic design are being combined with high performance in new Bourns accelerometers, pressure transducers, linear motion potentiometers, and other electro-mechanical devices. When your requirements need the experience of a leader—look to BOURNS.

Write for detailed technical information on Model 717

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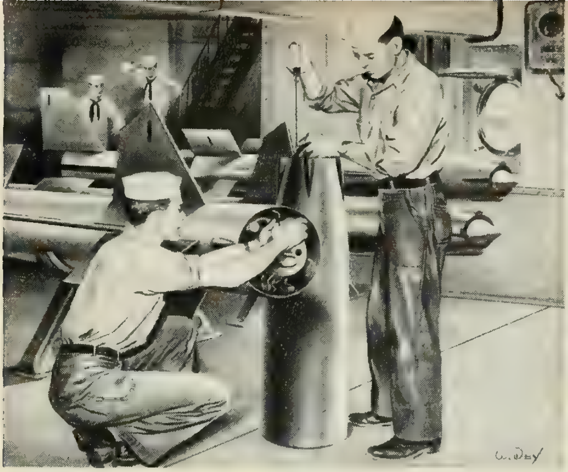

MISSILE COMPONENTS Bulova safety and arming systems protect ground, air and sea crews from load to launch, then take over in flight. Safety factor of one in a million is specified and reliably delivered by Bulova's precision production facilities. Powder-driven gyros and fuzing systems are among other Bulova developments for 18 key missiles.

AIRCRAFT INSTRUMENTS Bulova's new Servo Altimeter assures maximum reliability through unprecedented sensitivity, accuracy and repeatability. At 40,000 feet, it detects 4-foot changes . . . is correct to 40 feet. Safety is improved in traffic control and flight over difficult terrain. As a control instrument, it is readily adaptable to guided missiles.

Bulova reliability helps to solve today's most challenging problems

For more than 80 years, Bulova has charted new courses in the area of reliability.

Milestones along the way are the electronic and electro-mechanical devices created by the Bulova capability—the uncommon blend of pioneering vision and precision production experience.

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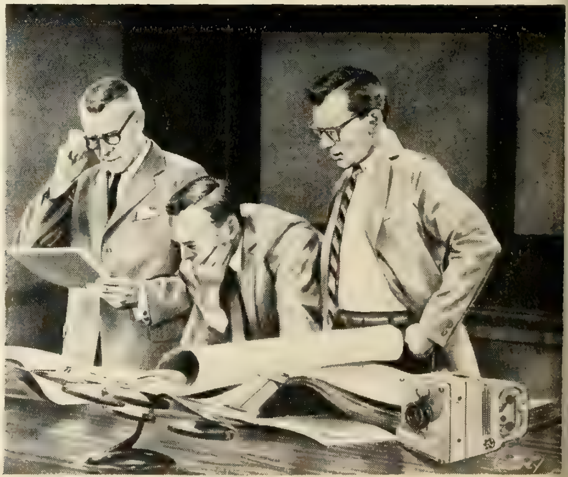
INFRA-RED COMPONENTS Bulova infra-red cells are designed to unerringly guide Sidewinders to target. Bulova-improved production processes increase yield and product reliability. Other infra-red developments include filters, reticles and thermistor bolometers, as well as advanced research in mosaic and lead selenide cells.



PHOTOGRAPHIC SYSTEMS Bulova's new high performance 70mm recon-camera features 8 frame/sec. and pulse operation . . . vibration-free exposures to 1/4000 sec. From the smallest 16mm gun camera ever built to units of 9x18" format size, Bulova developments include optical, data recording and instrumentation, and special sequence cameras.

Engineers and Designers interested in creative opportunities are invited to submit their qualifications to Dr. R. Hershey, Personnel Mgr., Bulova R&D, 62-10 Woodside Ave., Woodside 77, N.Y.

Circle No. 15 on Subscriber Service Card.

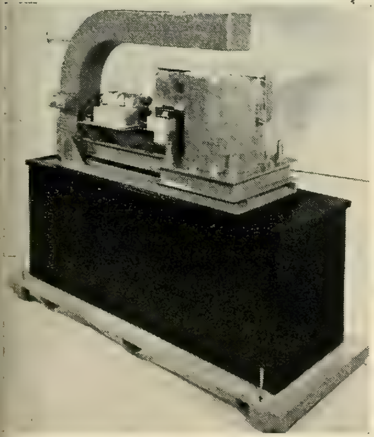
airborne applications, and EM 472 for use in laboratory and ground support equipment.

The new transient eliminators when placed in series with power sources, absorb high-voltage transients and prevent their appearance at the output of the elimination thus protecting the transistor load.

Both units are rated for continuous operation at 32 VDC and 15 Amps., and satisfy military specifications, MIL-E-5272. Other outstanding features are portability, lightweight, short circuit proof, high reliability, no stand-by power and little line drop. The units are protected against reversed polarity, inductive kick-back and over-voltage.

Circle No. 233 on Subscriber Service Card.

Noncontacting Gage Checks Material Properties



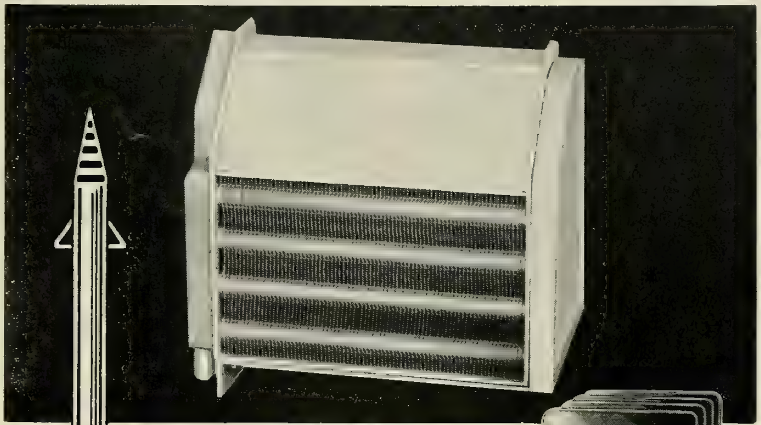
Gammascan, a new noncontacting gage has been put on the market by **Nuclear Systems,** a division of the Budd Company. The machine continuously measures the thickness and density of materials through the use of gamma radiation.

The gammascan's thickness capability ranges from light gage metals to more than a foot of steel or equivalent. The machine can inspect a wide variety of products such as rolled sheet steel, extruded forms and solid fuel for missiles.

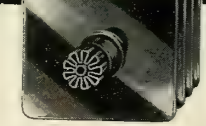
In operation, gamma radiation from he machine's throroughly shielded Cobalt 60 source passes through the material being inspected to a scintillation detector which converts the radiation o an electrical current. Variations in his current are interpreted by the gammascan as changes in material hickness or density.

Gammascan's output is indicated isually on a meter calibrated in thickess increments and can be fed to a

INNER-FIN
HEAT EXCHANGER



TYPICAL INNER-FIN HEAT EXCHANGER



provides cooling for missiles

Dunham-Bush Inner-Fin heat exchangers in Electronic Tube Cooling Units have proven the answer to the ever-present space problem in aero-electronic heat transfer.

Inner-fin coils have effected a 60% savings in coil sizes in units. Maintaining the same air and liquid pressure drops through the coil, an Inner-fin coil equivalent in capacity to a standard finned tube coil occupied 60% less space.

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PHYSICIST—Familiar with the physics of gases and liquids, mechanical and electromagnetic wave propagation within these media.

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APPLIED MATHEMATICIAN—Experience in logical programming of systems and interest in communication and probability theory.

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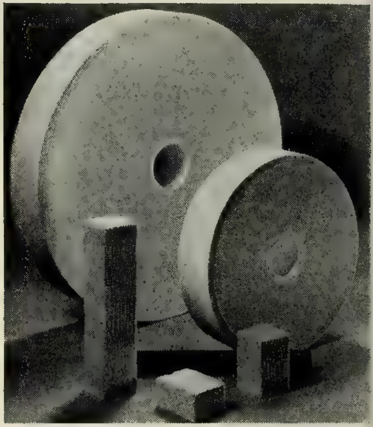
Thin-walled Ceramics for High-Temperatures



Extremely thin-walled ceramics formed into lightweight honeycomb structures, said to be capable of operating at high temperatures have been introduced by **Corning Glass Works.**

These materials, male by the new Cercor process, can withstand temperatures up to 1,000 C (1800 F) with virtually no thermal expansion, and can operate continuously at 700 C (1290 F). At these temperatures they are resistant to oxidation and corrosion.

A unique characteristic of these materials is their extremely low coefficient of thermal expansion—1 x 10-7 per degree C (from 0 to 300 C). They can withstand extreme thermal shock.

Available Cercor pieces have a compressive strength, parallel to the channels, of 2000 psi. Surface area of the 20-hole-per-inch corrugated structures is 1500 square feet per cubic foot of material.

Circle No. 235 on Subscriber Service Card.

220,000 psi Locknuts Offer High Strength

A new series of high strength, double-hex, external wrenching, self-locking nuts is now offered by the **Elastic Stop Nut Corp. of America** for advanced design high tensile bolting requirements. Design refinements are said to consistently develop the full fatigue strength of 220,000 psi bolts.

The new type LG3393 high tensile nuts offer the required performance characteristics, yet the manufacturer asserts they are from 10% to 33% lighter, size for size, than even the lightest 180,000 psi locknut. Further weight saving is made by the smaller envelope dimensions of the new parts, since reductions of the wrench clearance requirements permit reductions in the size of other structural components.

The new high tensile nuts are cold formed from alloy steel, cadmium plated with a supplementary molybdenum disulphide dry film lubricant. Presently available in thread sizes ¼-28, 5⁄16-24, ⅜-24, 7⁄16-20, larger sizes are now in design.

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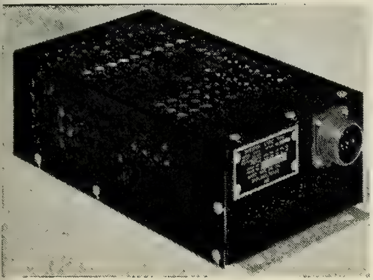
Static Inverter Handles Single and 3-Phase



The **Varo** Model 4309 static inverter is said to produce both single phase and three phase 400 cycle power from 28 VDC input. A Varo bimetalic tuning fork reference controls the frequency to 400 cps ± 0.1% over the environmental range of –55°C to +71°C.

Utilizing transistors in a bridge switching circuit for maximum reliability, 170-210 VA of single phase power and approximately 50 watts of three phase power are obtained from a unit weighing only 9½ pounds. The design of the bridge inverter is such as to allow operation to 71°C without heat sinks or cooling air. It also enables the unit to operate with up to 35 volts input for short periods of time.

Circle No. 237 on Subscriber Service Card.

Magnetic Read Head For Control Systems

A new 83-Channel per inch magnetic read head has been developed in **Stanford Research Institute's** Control Systems Laboratory. The read head promises to be useful with magnetic drums, magnetic tape transports, facsimile and other applications.

The crosstalk between adjacent channels is down by more than 20 db in the present head, and is negligible between non-adjacent channels.

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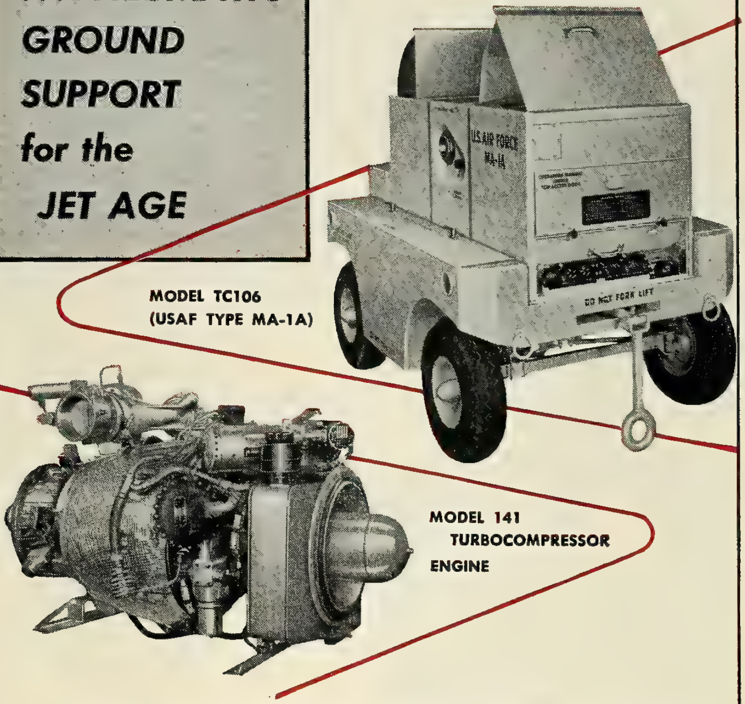

MODEL TC106
(USAF TYPE MA-1A)

MODEL 141
TURBOCOMPRESSOR
ENGINE

Typical of the fine results of Continental development is the TC106 trailer-mounted, portable gas turbine compressor unit suitable for starting large jet engines and ground check-out of air conditioning and cabin pressurization systems. The hot discharge air blast can also be used for other purposes such as removal of ice and snow from aircraft surfaces. This advanced model, built around its dependable Model 141 turbocompressor engine, features high performance, excellent mobility, low noise, and a completely automatic control system. This pneumatic compressor package can also be furnished without the trailer for any custom-engineered installation. . . . It is now in volume production at Continental's Production Division, Toledo, Ohio.

CAE turbojet engines—the J69-T-9, the J69-T-2, and the J69-T-19B are in volume production for the Cessna T-37A twin-jet trainer, the Temco TT-1 jet trainer, and the Ryan Q-2A Firebee target drone respectively.

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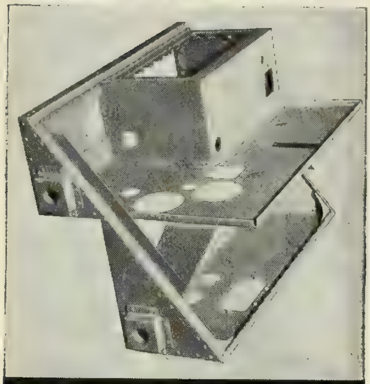

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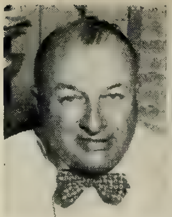
missile business



by Fred S. Hunter

Big personnel procurement pitch on the west coast currently is slanted toward electronics. If you can qualify in this field, you've got it made.

Take the top jobs advertised by one Los Angeles placement agency, four positions at $30,000 per annum. All except one require a Ph.D in electrical engineering. The exception is for a Ph.D, too. Any kind of a Ph.D, apparently.

A recent Los Angeles Sunday paper had 12 pages of help wanted advertising, most of it for engineers and scientists allied to electronics or some facet of missile design and development. Imagine running a help wanted advertisement for a scientist. It's happening every day in Los Angeles.

Company doing the most personnel procurement advertising at this time is Lockheed for its Missile Systems Division, with openings available at Sunnyvale, Van Nuys and Santa Maria. Latter means Vandeburg Air Force Base and the Pacific Missile Range. Lockheed's MSD lists about 25 job categories where shortages exist and 90% of the areas involve electronics.

Other companies advertising heavily in the Los Angeles market: Hughes Aircraft Co., (both for its Culver City and Fullerton plants); Space Technology Laboratories (Ramo-Wooldridge); Systems Development Corp. (Rand); Aerojet-General Corp., (for Azusa and Sacramento); Douglas-El Segundo; Northrop Aircraft (Nortronics division); General Electric (for Tempe, Ariz.); RAC, and Marquardt Aircraft Corp. (for Ogden and Van Nuys). In practically every category, electronics and/or missiles are involved.

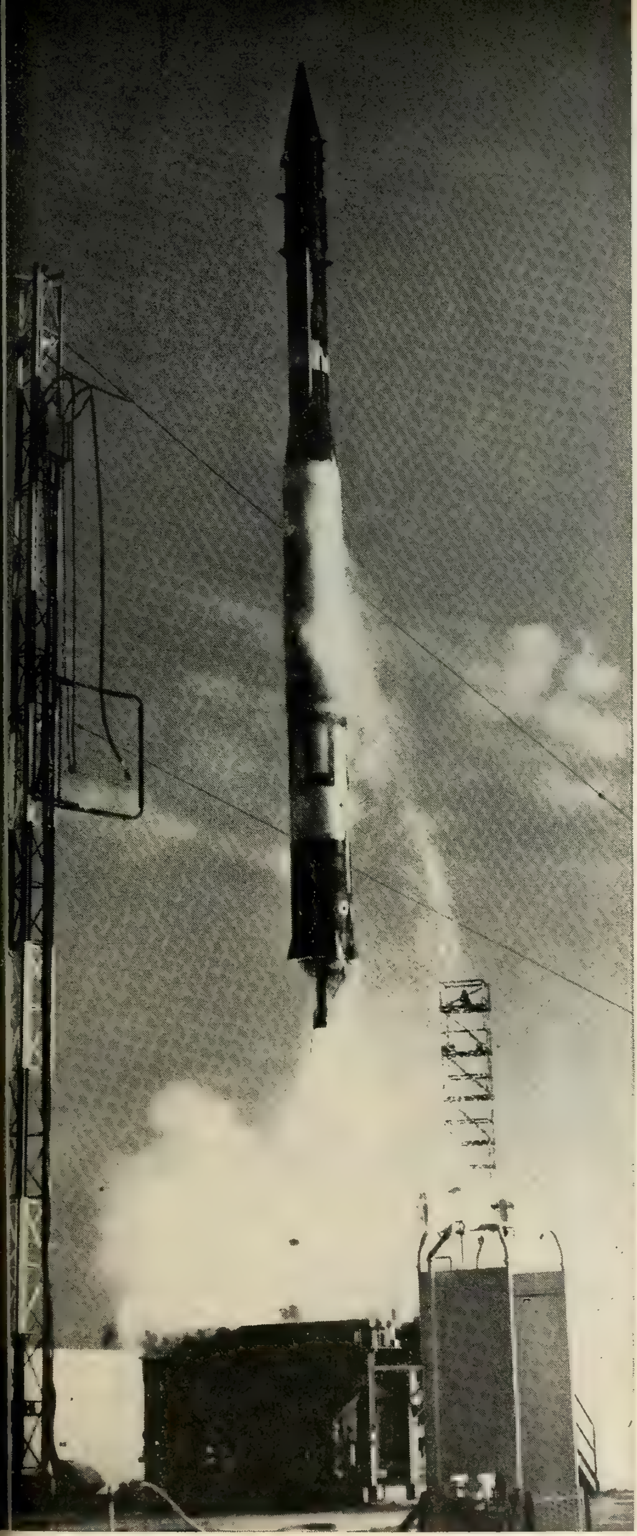
There is a great deal of demand for experts in reliability, a rather gratifying thought. Considerable searching is being done for computer programmers or for trainees in this field, a hard one to fill at the moment.

Aerojet-General's $19.3 million order from the Navy to build the hydrodynamic frame of a high speed torpedo, as well as the propulsion system, may provide an opportunity for the rocket manufacturer to show what it can do in explosive metal forming, or aeroforming as it is called. The navy is highly interested in developments in this method of fabrication, and has been conducting studies at China Lake for about nine years. Aerojet is very active and has a proving ground at Chino, where recently it conducted its 10,000th test firing.

The rocket industry is heading toward unusual shapes and large dimensions where conventional deep draw and spinning methods won't suffice. Explosive forming may be the answer. Aerojet currently is working on the forming of pressure domes that may be used in missile production.

In this process, a large metal bowl-shaped portable mold is backed in concrete. The blank to be formed is secured over the mold, after which an explosive charge is suspended above it. A vaccum is created in the mold, the entire unit is lowered into a tank of water and the charge detonated. Water pressures from the explosion forms the blank. Aerojet says this new fabricating process, although still in experimental stages, shows signs of having a bright future.

Company notes—Air Force Sales Unit of **GE's Heavy Military Electronics Department** set up an advanced development sales organization, to aid military customers in keeping track of GE activities . . . **Growth Industries Group, Inc.,** designed to supply management skills, organized in New York City.



Successful Vanguard equipped with Union miniature relays

March 17, 1958—Union Switch & Signal 6 PDT miniature relays functioned perfectly in the separation controls between the first and second and second and third stages . . . in the first stage propulsion unit . . . and in the third stage spin control assembly of the satellite-bearing Vanguard.

The Martin Company, builders of the Vanguard, chose these outstanding relays for their reliability . . . for their simple, rotary design . . . and for the expert quality control associated with the established leader in electrical relay design—Union Switch & Signal.

The 6 PDT relay used in the Vanguard is just one of a complete line of *dependable* relays designed by Union Switch & Signal—"Pioneers in Push-Button Science." Send the coupon for complete technical information.

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Pittsburgh 18, Pennsylvania

Please send information on the following:

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contract awards

ARMY

By Ordnance Disrtict, Los Angeles:

Hughes Tool Co., Culver City, Calif., received $142,117 for development of devices to produce nuclear environments.

North American Aviation, Inc., Canoga Park, Calif., received $50,000 for rocket engines.

Gilfillan Bros., Inc., Los Angeles, Calif., received $124,048 for requirements of spare parts for the *Corporal* missile system.

Firestone Tire & Rubber Co., Los Angeles, received $163,031 for concurrent repair parts for *Corporal* missile.

Douglas Aircraft Co., Inc., Santa Monica, Calif., received $45,251 for repair parts for the *Nike* system.

Douglas Aircraft Co., Inc., Santa Monica, Calif., received $64,074 for repair parts for the *Nike* system.

By San Francisco Ordnance District:

Lockheed Aircraft Corp., Lockheed Missile Systems Div., Sunnyvale, Calif., received $64,954 for feasibility study for target missile system.

By Engineer District, Jacksonville, Corps of Engineers:

Diversified Builders, Inc., Patrick AFB, Fla., received $195,000 for construction of addition to engineering and lab building, Cape Canaveral Missile Test Annex, AFMTC.

By Corps of Engineers, Office of the District Engineer:

Shelby Electric Co., Inc., Memphis, Tenn., received $239,967 for installing controls and instrumentation for coolers nos. 2 and 3 for the supersonic circuit of the propulsion wind tunnel.

By New York Ordnance District:

Western Electric Co., Inc., received $2,200,000 for production engineering services for the preparation of ordnance documentation for the *Nike-Hercules* guided missile system.

Chrysler Corp. received $27-million for producion of *Redstone* missiles and components.

AIR FORCE

Extrusions, Inc., Caldwell, N.J., received $85,780 for development of a process for the extruding of titanium and steel alloys by use of explosives.

Titanium Metals Corp. of America, New York 7, N.Y., received $121,208 for development for an improved method for mechanically removing the oxygen—rich contaminated surface layer resulting on titanium alloys after exposure to air at elevated temperatures.

By AMC HQ:

Vitro Engineering Co., Vitro Corp. of America received $2,627,332 for maintentance and operation of SAGE utilities sysetms.

Vinnell Co., Inc., received $1,005,919 for maintenance and operation of SAGE uitlities systems.

RCA Service Co., Radio Corp. of America, received $361,564 for maintenance and operation of SAGE uitlites sysetms.

Aircraft Gas Turbine Division, General Electric Co., received $66,511 for research on "Radiation in Rocket Motors."

Arthur D. Little, Inc., received $40,665 for continuation of research on "Combustion Ignition."

Bell Aircraft Corp. received $115,734 for continuation of "Program of Exploratory Research."

Boston University received $28,343 for research on chemical properties of active nitrogen.

University of Maryland received $32,000 for continuation of research on the theory of scattering.

Westvaco Chlor-Alkali Division, Food Machinery and Chemical Corp., received $37,240 for rocket propellant.

American Chain & Cable Co., Inc., American Cable Division, received $28,744 for steel retrieving cable assemblies.

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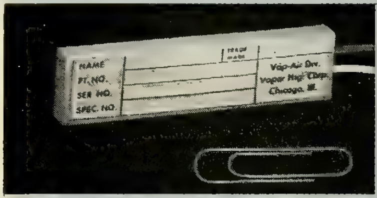

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Though absolute reliability of any similar device is impossible to guarantee—a bitter fact of life recognized by all electronic engineers—close approach to this goal by the relays manufactured by The Hart Manufacturing Company is the basic reason they are found today on many of this country's headline-making missiles.

In addition to contact force far beyond that found on other relays, "Diamond H" relays have greater contact cleanliness. Self-contamination is virtually eliminated by a completely inorganic switch mechanism, as well as use of coil materials which will not dust, flake or out-gas.

Finally, the high degree of reliability that is designed into these relays is maintained in their manufacture by high quality workmanship and a stringent inspection policy at every stage.

In addition to missiles, and their ground control systems, Series R and S relays are designed for use in jet engine controls, computers, fire control, radar and similar critical applications.

4PDT units, they offer an extremely broad range of performance characteristics, including temperature ranges from —65° C. to 125° and 200° C.; ratings to 10 A., 120 V., A. C., and 26½ V., D. C., with special ratings to 400 ma. at 350 V., D. C., or down to millivolts and milliamperes. Dry and wet circuits may be safely inter-mixed.

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space age

by Norman L. Baker

Aurora borealis blocks missile detection—Radiations of the aurora borealis are proving a tremendous headache to scientists formulating plans for missile defense. Existing radar scopes of the North American Air Defense Command in the Arctic have discovered that the northern lights have, in many instances, rendered radar detection apparatus incapable of operation. A Canadian scientific group plans to send high altitude rockets into the borealis to release chemicals for the study of effects of these impediments to radar and radio operation.

Gamble in lunar probe—Canaveral personnel working on the Air Force's lunar program can't understand why the week proceeding the first attempt was not utilized for two or three dry runs. Trial runs would have eliminated countdown confusion in the race to get the vehicle off the pad at the precise time.

The entire operation was probably lost when the decision was made to gamble with an early loxing operation in a false sense of preparedness.

Liquid rocket engineers place the maximum pre-launching time for loxing a missile at 45 minutes. Confinement of liquid oxygen beyond this time initiates a multitude of problems—metal in contact with the LOX begins to crystallize and valves operate sluggishly or not at all. Heaters can be placed around the valves—and this is usually done.

At launch, when the crystallized metal is subjected to acceleration, vibration and pressure—anything can happen. The tanks or lines can rupture at the seams and joints as was the reported case in the first lunar shot (m/r, Aug. 25, p. 13).

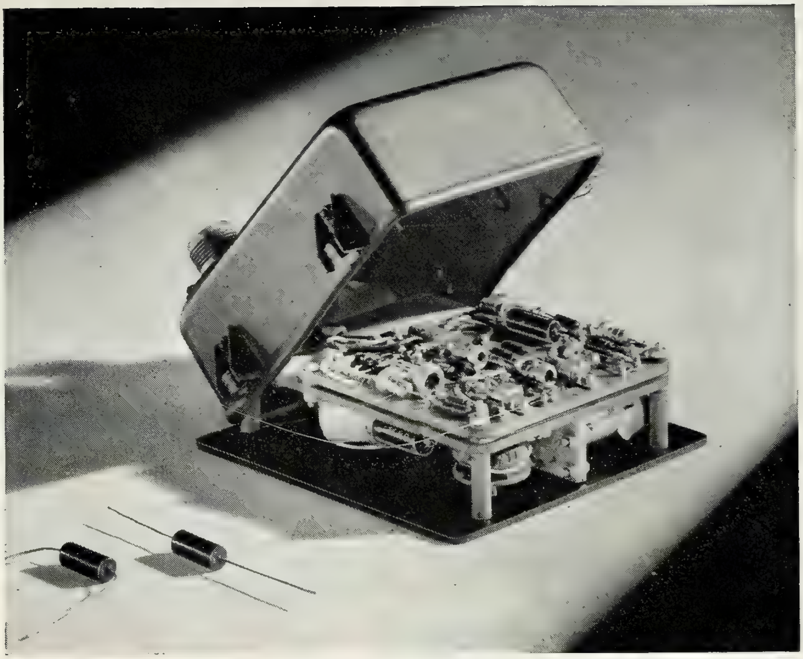
Moon-Sun boomerang—A rocket to the sun with an assist from the moon for probing the solar atmosphere has been suggested by R. P. Haviland of General Electric as a project worthy of consideration during the period of extended IGY activities. By employing a "crack-the-whip" technique effected by the centifugal force generated by the moon in its orbit around the earth, a near approach to the sun would be possible, according to Haviland.

Major holdback—Accurate guidance for bringing the vehicle near enough to the moon to take advantage of the moon's orbital velocity—about 3600 mph—without being pulled into an orbit about the moon or impacting with it. Fifty-pound probes could be sent as far as Mercury, using five-stage vehicles with 250,000-pound take-off weights. Closer approaches would require additional stages or additional take-off weights.

***Vanguard* must fire quickly**—Once the *Vanguard* launching vehicle has been fueled up in preparation for firing and then emptied during a hold, a new firing date must be scheduled within a matter of days. The acid oxidizer in the second stage resists complete dilutation during the draining and flushing operation, consequently, a slow deterioration of lines and tanks is soon underway. This was the major factor in setting the second firing date for SLV-3 ten days after the first attempt.

The NRL scientists are not the only people eagerly awaiting a successful launch of a full-size *Vanguard*. Many IGY scientists fully aware of the error probability of the *Explorer*-type of satellite with the attached metal hardware inducing interference, have high hopes for the spherical *Vanguard*.

Airborne Miniaturized Mylar* Capacitors help **reduce weight and bulk** in electronic packages



Amplifier for oil temperature servo control system utilizes Airborne miniaturized "Mylar" capacitors to save weight and insure high reliability. Entire system, including rotary actuator, is Airborne produced and is designed to meet specifications MIL-E-5272A, MIL-E-5400A, etc. Environmental requirements include −65 to +200°F. and up to 60,000 ft. altitude.

Developed originally for motor start and run purposes, Airborne miniaturized "Mylar" capacitors are currently finding increasing application in electronic circuits where small size, light weight, and high reliability are of paramount importance.

Typical of such applications is one of our *own* servo control amplifiers, shown above. Used as a component of an Airborne-designed oil temperature control system for high performance aircraft, the amplifier consists of a .1% precision resistance bridge, stable feedback transistor amplifier, reference oscillator, phase demodulator, and relay output amplifier. Production units employ printed circuitry.

Two of Airborne's miniaturized "Mylar" capacitors are utilized in this particular amplifier — a .1 mfd unit for tuning in the reference oscillator section of the amplifier and a .02 mfd unit for phase shift correction in the stable feedback transistor amplifier section. Capacitors are epoxy encased and are designed to meet or exceed Government specification MIL-C-25A.

Wound of thin metallized "Mylar" film, Airborne miniaturized capacitors are rated up to 600 v d-c, 330 v a-c and have an operating temperature range of −75 to +300°F. At 300°F they will withstand 120% rated voltage for 250 hr.

Write, phone or wire for more information on Airborne special design miniaturized "Mylar" capacitors. Inquiries are also invited on complete electromechanical control systems.

*Du Pont's trademark for its polyester film

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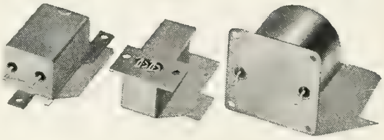

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CATALOG 57B

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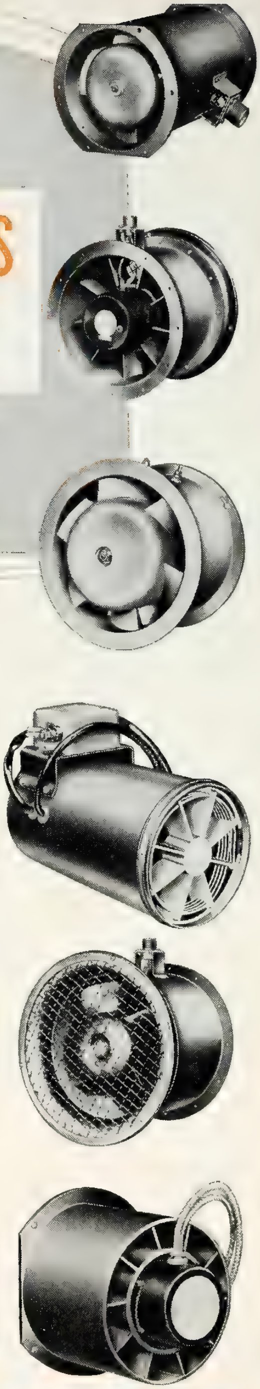

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when and where

OCTOBER

Armour Research Foundation and Illinois Institute of Technology, Annual Noise Abatement Symposium, Hotel Sherman, Chicago, Ill., Oct. 9-10.

Fuels-AIME Conference, American Society of Mechanical Engineers, Old Point Comfort, Va., Oct. 9-10.

14th Annual National Electronics Conference, Hotel Sherman, Chicago, Ill., Oct. 13-15.

ASME, Lubrication-ASLE Conference, Statler Hotel, Los Angeles, Calif., Oct. 14-16.

Association of the United States Army, 1958 annual meeting, Sheraton-Park Hotel, Washington, D.C., Oct. 20-22.

URSI, IRE, USA National Committee Joint Meeting, Pennsylvania State University, University Park, Penna., Oct. 20-22.

IRE, 1958 National Simulation Conference, Professional Group on Electronic Computers, Statler-Hilton Hotel, Dallas, Oct. 23-25.

Fourth Annual Symposium on Aviation Medicine, Miramar Hotel, Santa Monica, Calif., Oct. 22-24.

SAMA Laboratory Apparatus and Optical Sections' Midyear Meeting, Westchester County Club, Rye, N.Y., Oct. 26-28.

Institute of Radio Engineers East Coast Conference, Aeronautical and Navigational Electronics, Lord Baltimore Hotel, Baltimore, Md., Oct. 27-28.

1958 National Metal Exposition and Congress, American Society for Metals, Public Auditorium, Cleveland, Ohio, Oct. 27-31.

IRE, 1958 Electronic Devices Meeting, Shoreham Hotel, Washington, D.C., Oct. 30-31.

NOVEMBER

Fifth Annual Meeting, Institute of Radio Engineers Professional Group on Nuclear Science, Villa Hotel, San Mateo, Calif., Nov. 6-7.

School of Aviation Medicine, International Conference, Physics and Medicine of the Atmosphere and Space, San Antonio, Texas, Nov. 10-12.

Conference on Scientific Information, AFOSR Directorate of Research Communication, NAS, NSF and the American Documentation Institute, Mayflower Hotel, Washington, D.C., Nov. 16-21.

American Rocket Society, 13th Annual Meeting and Astronautical Exposition, Hotel Statler, New York, N.Y., Nov. 17-21.

letters

More on Cable

To the Editor:

Re your special report on Wires and Cables: Vital to Missiles (m/r, Sept. 8, p. 23). You are to be commended on the Teflon section of the article. There is no doubt that the added reliability of Teflon-TFE-fluorocarbon resins far outweighs the increased cost of this material for wire and cable insulation.

The section on integrated cable-making does not appear to contribute appreciably to the art of manufacturing cables which has been in existence for many years by established cable manufaturers. The features described in this section of your report may not be available in a number of the makeshift cable machines which have been set up for the manufacture of jacketed harnesses by newcomers in the field.

However, we have several machines which have been in operation for a number of years which are equally adaptable to the manufacture of this type of cable. The ability to do this type of twisting is certainly not limited to one firm.

It would appear that one of the most important requirements, that of the cable jacket to protect these delicate components, is entirely missing in your report. The type of cable generally used in this area should be jacketed with an extruded reinforced neoprene covering so that the finished cable will be able to at least meet the minimum requirements for mechanical abuse and low temperature operation called out in MIL-C-13777A for class C Jacket if proper protection for the twisted complex is to be achieved.

D. C. Alexander
Chief Engineer
Surprenant Mfg. Co.

The examples given in the article were not intended to give the impression that these were the only sources available or capable of filling the needs . . . Ed.

The editors of MISSILES AND ROCKETS welcome contributions from readers in the form of letters. Such contributions often add greatly to the information of other readers about a complex technology and complex business operation. Letters should be addressed: "To the Editor, Missiles and Rockets, 1001 Vermont Ave., N.W., Washington 5, D.C." They should be signed and should include company or other affiliation of the writer. Contributions will be subject to some editing to fit space and style requirements.

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world astronautics

by Frederick C. Durant III

Krafft Ehricke, speaking recently on the problem of accuracy requirements of velocity cut-off in interplanetary journeys, stated that .5 ft/ sec (out of 37,000 ft/sec) was required for Venus; while .02 ft/sec accuracy was required for an un-powered ballistic flight to Mars. However, because of current lack of precise knowledge of the size and density of the planets, even with velocity cut-off of infinite accuracy we wouldn't know now *when* to cut-off!

Plastic models of spacecraft are becoming widely available and grace many professional rocketeers' offices as well as their youngsters' rooms. Easily assembled kits of space stations, lunar vehicles, as well as the X-17 and operational missiles, are marketed by a number of companies. Revell, Inc. of Venice, Cal. (whose models seem the best detailed) distributed hundreds of kits to guests at the National Missile Industry Conference held in Washington. Strombeck-Becker Mfg. Co., Moline, Ill. and Lindberg, Inc. Skokie, Ill. also have spacecraft models. Park Plastics Co., Linden, N.J. has a "pneumatic-hydraulic jet propelled" rocket for the youngster that will zoom to 100 feet.

The Polish Astronautical Society now has 500 members, and two new sections in Bydgoszcz and Lublin. At the elections last spring, Prof. Z. Padzkowski was named president, Prof. Dr. K. Zarankieweicz, vice-president. Active and growing, the Polskie Toworzystwo Astronautyczne (PTA) sections in Krakow and Lublin plan to construct meteorological rockets.

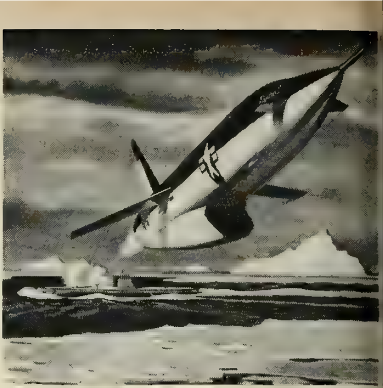
From Germany comes news that a research laboratory has recently been established at Bonn University Observatory to monitor satellite signals. *Sputnik* 3 signals have been received and recorded. Also, August Staats of the Dafra, Bremen, reports that his group will launch a 50 km. altitude sounding rocket soon to obtain meteorological data in connection with IGY activity.

Time moves swiftly. It is interesting to note that President Eisenhower signed the bill forming the NASA on July 29, 1958. This date is exactly three years after his announcement of project *Vanguard*. The next three years may continue this rate of astronautical progress, probably including several successful manned satellite flights.

According to Dr. O. Wolczek, of the Nuclear Research Institute, Wausau, a 20 metagon hydrogen bomb exploded sixty million miles in space would produce a light of equivalent brightness of venus. Wolczek believes that such an experiment would provide valuable data to astrophysicists in simulating natures method of forming stars. Data might be obtained through the use of unmanned space observation craft.

On the occasion of the 25th anniversary of the British Interplanetary Society, a symposium on space medicine will be held in London, October 16-17. Cdr. George W. Hoover, USR, sparkplug of Project Orbiter, will speak on the "Man-Machine System in Space Vehicles."

Office of Technical Services (US Dept of Commerce) plans to publish an English translation of Alexander Sternfeld's 433 page book, "Artificial Satellites." Price will be six dollars. Sternfeld is a well known, semi-popular writer and long time promotor of Astronautics in the USSR.



KEY OPENINGS IN AERODYNAMICS, FLIGHT TEST

Chance Vought is adding several men with strong aerodynamic or flight test backgrounds to help man accelerated programs. Assignments involve Dyna-Soar, *Regulus* missiles, F8U *Crusader* fighter series, ASW studies and sophisticated electronics developments. Following are priority openings:

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Telemetry Engineer. B.S.E.E., or M.S.E.E., with 5 to 6 years experience in the electronics of telemetering. To guide R & D in the design and application of electronic data.

Operations Research Specialist. Requires M.S. degree, or equivalent, in mathematics, or physics, plus experience specifically in Operations Research. Should be able to develop and apply mathematical models to problems encountered in developing airborne weapon systems; analyze aircraft systems, tactics, logistics and operational capabilities.

Stability & Control Engineer. M.S. preferred, with experience in autopilot and/or stabilization system analysis and design. To guide design and analysis of advanced concepts in automatic controls and stabilization. Spectrum: from initial concept and analogue computer solutions through hardware design to flight simulator and test of the system.

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C. A. Besio
Supervisor, Engineering Personnel
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in′ge·nu′i·ty: *designing a 12-ton missile to fit inside an atomic sub*

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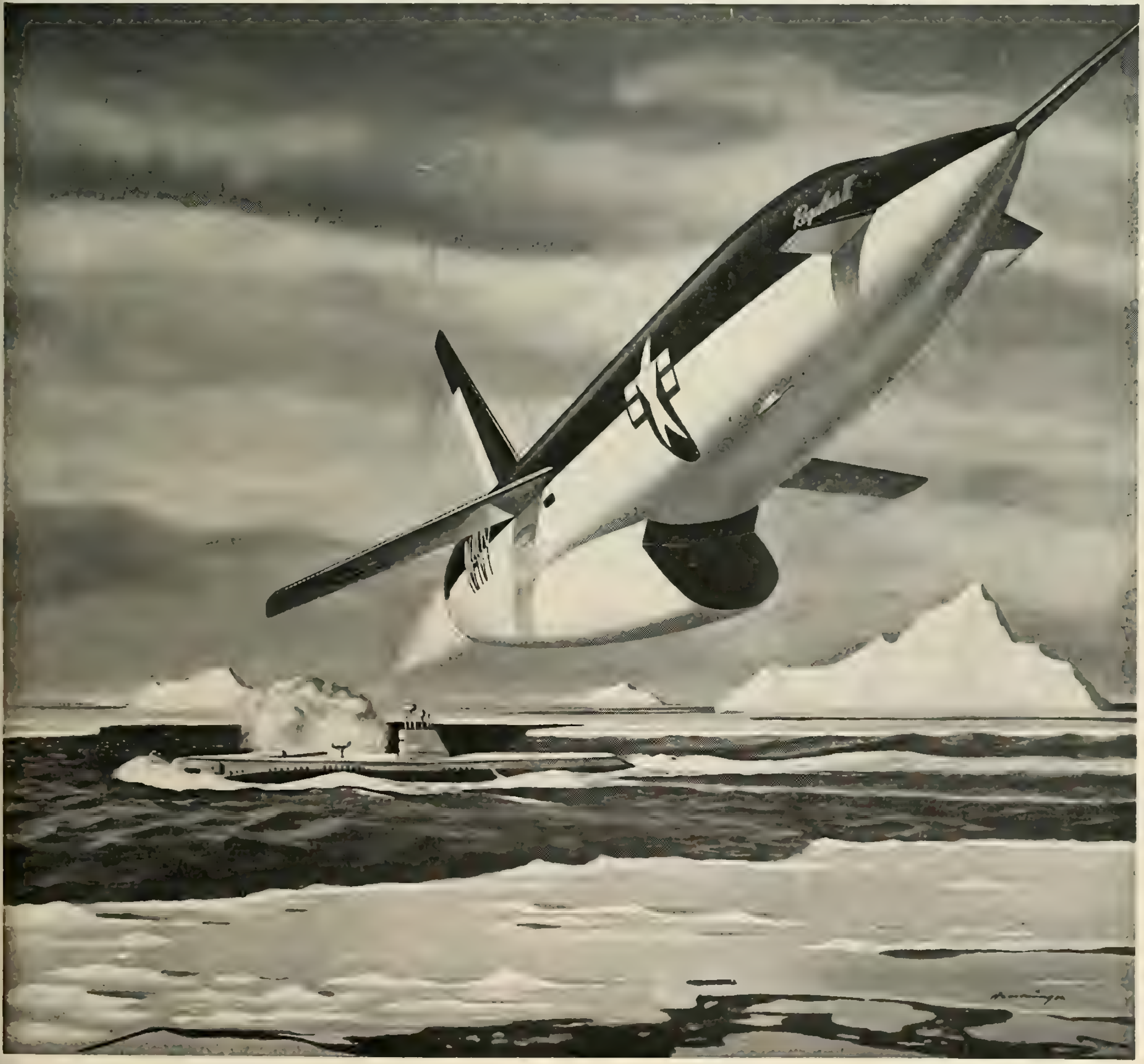

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book reviews

PRINCIPLES AND APPLICATIONS OF RANDOM NOISE THEORY by Julius S. Bendat, 431 pp, $11, John Wiley & Sons, N.Y.

This study, written by a senior staff member of the Ramo-Wooldridge Corp., will be of interest to those in the fields of statistical communication theory, systems analysis, automatic control, meteorology, aeronautics, radar, product testing, and other related studies.

Principles of random noise analysis and optimum filtering techniques are explained, with emphasis on physical meanings and mathematical restrictions. The author shows how to formulate difficult noise problems, how to solve them mathematically and how to draw appropriate physical designs and interpretations.

Other areas covered by Dr. Bendat include the Zero-Crossing problem, statistical errors in correlation measurements, advanced optimum time-variable designs and methods of analog computer simulation for noise problems.

HANDBOOK OF PHYSICS, edited by E. U. Condon and Hugh Odishaw, McGraw-Hill, New York, New York, 1504 pp., $25.

A comprehensive and authoritative guide to basic physics, it deals with the principles, ideas, concepts and advanced mathematical methods of all branches of classical and modern physics.

The emphasis is on the principles of physics and the mathematical techniques required for their exposition. Within this framework, the main sections cover mathematics, mechanics of particles and rigid bodies, mechanics of deformable bodies, electricity and magnetism, heat and thermodynamics, optics, atomic physics, physics of the solid state, and an analysis of nuclear physics.

1957 VACUUM SYMPOSIUM TRANSACTIONS; American Vacuum Society, 176 pp., $12.50, Pergamon Press, New York.

This symposium study includes papers on the fundamental developments of vacuum technology and engineering, new methods and techniques for obtaining high vacuum, instrumentation, controls and other vacuum devices used in current technological methods.

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Moscow briefs

The U.S. Army's surface-to-air guided missile *Hawk* is the subject of particular Soviet attention in recent weeks. This is evidenced by the lengthy article in SOVETSKAYA AVIATSIA of August 15 on American, French, and other Western defenses against low-flying craft. The author, Lieutenant Colonel B. Surikov of the Soviet engineering forces, uses an official U.S. Army photograph of the *Hawk* as his article's only illustration.

He devotes nearly one-half of his text to the *Hawk*. After listing, from U.S. and other Western sources, all the available data on the *Hawk's* range, frame, guidance, and power plants, the Soviet officer cites all the pros and cons usually advanced by the non-Soviet admirers and detractors of the *Hawk*. However he extends more of his space and support to the criticism of the *Hawk* than to the praise of it.

Discussing Soviet ideas on the future rocket-plane and its gliding feature, Professor V. S. Pyshnov remarks in SOVETSKAYA AVIATSIA: "It turns out that even a glider, which has always been a synonym for a slow-motion flying apparatus, can, in the future, compete with a ballistic rocket. Give it great speed initially—and it will glide pretty much around the globe."

"Soon the first interplanetary flights will be a reality, even before the majority of you finish your schooling." So wrote Professor N. A. Varvarov in KOMSOMLSKAYA PRAVDA, on August 31, in his greetings to Soviet teenagers on the eve of the opening of the new 1958-59 school year. A prominent astrophysicist, Dr. Varvarov is chairman of the Astronautics Section of DOSAAF. (These initials stand for the Russian name of the Volunteer Organization of Aiding the Army, the Air Force, and the Navy of the Soviet Union, the civil-defense apparatus of that country.) His greetings were headlined: "You Are Destined to Discover Other Planets."

Russia's oldest astrobotanist, Professor G. Tikhov, claims that astrobotany was born in Russia in 1946, at the Alma-Ata astronomical observatory in the Soviet Kazakhstan, Central Asia. Writing in KOMSOMOLSKAYA PRAVDA, Dr. Tikhov again insists that there is vegetation on Mars and that by now Soviet and other astrobotanists "have established certain characteristics of Martian plants."

The work of his Alma-Ata laboratory (attached to the observatory) has led to "an opportunity to study the outer-space life, not of vegetation alone, but also of micro-organisms." He declares: "Thus, astrobotany has grown into astrobiology."

He states his belief that beginnings of life are possible, not only on Mars, but also on Jupiter, Saturn, Uran, and Neptune, despite their extremely low temperatures. He argues that not even extremely low temperatures can prevent certain rudimentary forms of life from arising. "Our study of micro-organisms on these giant faraway planets will allow us to penetrate the mystery of life's beginning, by far not yet clear to our contemporary science," he said.

The dynamics of the orbiting of an earth satellite in relation to its own center of gravity is among the subjects absorbing the attention of Professor Leonid Sedov. In a recent paper on this topic, the top-rank Soviet astrophysicist stated that this dependence noticeably affects the magnitude of air resistance encountered by the satellite.

This influence must be taken into consideration in various scientific appraisals of the satellite-yielded data, such as in research having to do with ascertaining the density of the upper atmosphere. Professor Sedov reveals that *Sputnik* III, on reaching the lowest part of its orbit and passing through the upper atmosphere, "is decelerated with the force of nearly four grams."

Scorn for nonpatriotic Russian detractors of the three *Sputniks* is expressed by Vasily Ardamatsky in LITERATURNAYA GAZETA. According to Ardamatsky, some Russian grumblers would rather stop in the streets of Moscow to admire a parked foreign "fish-shaped" automobile with a fancy diplomatic license plate than boast of his native *Sputniks.* A goodnatured reminder by a patriotic passerby to the unpatriotic car-admirer is quoted in the article: "Don't forget our *Sputnik!*" But the renegade Russian replies scornfully: "Let others fly in it—those with their higher educations."

The unpatriotic Russian is also shown by the author as complaining about too many Russian automobiles being ridden by "too many academicians"—his dig at the Soviet astrophysicists and rocket experts with their privileged status. The "traitor" is also accused by the Soviet journalist of dismissing his government's proud tales of *Sputnik* III with a bored and cynical "So what?"

Instead of applauding the *Sputnik,* the "traitor" is busily spreading somebody's "sticky fables, from Dulles' best dreams, that in America they have allegedly sent a rocket to the Moon and that television programs are being broadcast from there." Comrade Ardamatsky broadly hints that the Soviet government should do something about such disorderly disloyalty.

Swifter speeds for *Sputniks* are revealed by the Moscow authorities. It is announced that after the first 1,000 round trips *Sputnik* I circled our globe in 3.5 minutes less, *Sputnik* II in 3.9 minutes less, and *Sputnik* III in 0.85 minute less. The initial orbit time was 96.2 minutes for *Sputnik* I; 103.7 minutes for *Sputnik* II; and 106 minutes for *Sputnik* III.

Soviet praise for Czechoslovak observation of earth-satellites was officially voiced in Moscow. The results of optical observation made at the observatory at Skalnaté Pleso in Slovakia were highly rated. Dr. Emil Buchar, a Czech scientist, announced that on the basis of Czechoslovak observations he had deduced a much more exact calculation of the deformation of the earth's sphere than was available.

Dr. Vladimir Guth, of the Slovak Academy of Sciences, is continuing his research on the content of cosmic dust.

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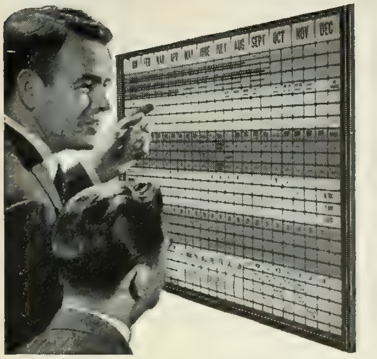

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advertisers' index

Airborne Accessories Corp.	49
American Bosch Arma Corp.	16
Amphenol Electronics Corp.	26
Avco Mfg. Corp., Crosley Div.	35
Bourns Laboratories, Inc.	39
Brush Instruments, Div. of Clevite Corp.	54
Bulova Watch Co., Research & Development Laboratories, Inc.	40
Chance Vought Aircraft, Inc.	52, 53
Clary Dynamics	8
Continental Aviation & Engineering Corp., Sub. of Continental Motors Corp.	43
Dit-Mco, Inc.	20
Dunham-Bush, Inc.	41
Electro Instruments, Inc.	64
Engelhard Industries, Inc.	61
Ets-Hokin and Galvan	59
Farrand Optical Co., Inc.	46
Fluorocarbon Products, Inc.	38
Foote Bros. Gear & Machine Corp.	22
Genisco, Inc.	4 & 5
Goodyear Tire & Rubber Co., The	3
Graphic Systems, Inc.	60
Grove Valve & Regulator Co.	63
Hart Mfg. Co.	48
Haydon Switch, Inc.	61
Industrial Engrg. Corp.	57
International Business Machines Corp.	30
James, Pond & Clark	36
Jet Propulsion Laboratory, Calif. Inst. Technology	6
Joy Mfg. Co.	50
Kaman Aircraft Corp.	44
Walter Kidde & Co., Aviation Div.	58
Kin Tel, A Div. of Cohu Electronics, Inc.	2
Kollmorgen Optical Co.	15
La Vezzi Machine Works	37
Wallace O. Leonard, Inc.	46
Lone Star Plastics Co., Inc.	36
Mallory Sharon Titanium Corp.	34
McCormick Selph Associates	18
Newbrook Machine Corp.	51
N. American Aviation, Inc.	33
Pacific Scientific Co.	29
Photocon Research Products	37
Pressed Steel Tank Co.	55
Pure Carbonic Co., a Div. Air Reduction Sales Co., Inc.	28
Raybestos-Manhattan, Inc.	32
Republic Aviation Corp.	19
Robinson Aviation, Inc.	27
Simmons Fastener Corp.	12
Thompson Products, Inc.	42
Union Switch & Signal, Div.-Westinghouse Air Brake Co.	45
United Aircraft Products, Inc.	10
Vapor Heating Corp.	47
Welwyn International, Inc.	21
EMPLOYMENT SECTION	
General Electric Co.	60
Marquardt Aircraft Co.	59, 60, 61
Standard Oil Co. (Indiana)	59

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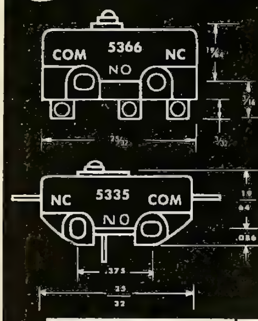

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editorial

Ahead of Schedule

The politics of an election, of defense streamlining, and of big industries dependent for survival on Government contracts, are beginning to affect our missile programs in a dangerous way.

The Administration—interested in balancing the budget—is trying hard to find ways and means of cutting defense expenditures. Already there has been some talk about killing the *Titan* ICBM as a weapons system.

The President himself has been led to believe that some of our missile programs actually are *ahead of schedule,* and this thinking has been relayed to the public in recent months.

With an apparent record of semi-successful ICBM and IRBM test shoots, with a series of small satellites in orbit, and with a vast hunk of glamorous publicity about the X-15 and other sophisticated Air Force projects, the Administration might succeed in convincing the tax-payers that the nation has caught up with our potential enemies.

A short while ago, Dr. Simon Ramo was quoted as having said we already *have* caught up with the Russians in the ICBM field.

The current feud between advocates of the *Nike Hercules* and the *Bomarc* as our standard anti-aircraft weapon also has added to the confusion and has made the public think we are wasting money on duplicate systems. It becomes obvious to the taxpayer that the *Nike-Bomarc* "duplication" is bad for the country and for our defense planning.

It is too bad this idea has become so firmly fixed in the public mind. Of course, the *Bomarc* and the *Nike Hercules* are different systems designed for different defense tasks; one for long-range area defense, the other for close-in city defense. It is good that Defense Secretary McElroy has had the foresight and courage, despite political pressure, to make the decision to continue both of these programs.

It is obvious that we have taken the wrong approach to many missile programs. It is equally obvious that such an approach has produced little operational hardware, but that it has—nevertheless—created a vast knowhow and sound engineering experience which will help us advance rapidly in the future. Today, however, we cannot afford to think that any of our missile programs are ahead of schedule.

We must realize that while the best technical approach might not always be the best policy, those who make the policy must know the best technical answer. So far, very few of our policy makers have known the best technical answers, simply because the entire field of missilery is too new and unexplored. This means that a great deal of industrial research and development—and sometimes what may appear to be duplicating research and development—must take place before we can expect to get any up-to-date systems into truly operational status.

For example, to many defense planners it now appears crystal-clear that the *Atlas* and *Titan* weapons systems are being outdistanced by the *Polaris*-type system, and that the latter is the logical one to be pushed to the extreme. But two years ago it just wasn't so. At that time the liquid-propellant ICBM was termed the ultimate weapon. In the meantime, the Air Force also has programmed its *minuteman*. Consequently, one may ask whether we will incorporate as many as *four* long-range weapons systems in the future. We probably will. For the time being—and for several years to come—these missiles systems will supplement each other, and thus they will represent an asset to our defense system.

These missiles are all different, engineering-wise. It is difficult to prophetize today if one is "better" than the other. Development must go on in all programs for the time being.

We also must face the fact, of course, that change-overs in science and engineering breakthroughs will continue until missilery becomes a science that we have mastered fully. Until then, we cannot afford to cut expenditures and we certainly cannot afford to assume that we are ahead of schedule, because our planners have no means of knowing the best technical answers.

The only thing that we can think of that might be ahead of schedule is the *Russian* missile program—ahead of *our* schedule.

Erik Bergaust

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NEW PRODUCT BRIEFS

PP,NG SWITCH. A new high-speed iature stepping switch is now avail- from IMTRA Corporation of Camge, Massachusetts. Called the highed "Miniature Uniselector," it is deed for use in automatic switching timing-control circuits. The Unictor will operate at speeds up to steps per second on impulse drive % make, 20% break) from a power ply of 24,50 or 110 volts d.c. Up twelve banks can be fitted, each ng 30 individual contacts mounted complete circle. When only seven ess banks are required, a sequence ch can be fitted. This takes the form an auxiliary bank of contacts and er assembly. The sequence switch er steps once for each complete lution of the main wiper assembly. wipers can be either bridging of bridging.

e No. 299 on Subscriber Service Card.

CTOR SHIELD. A telescoping idrical design Co-Netic subminia- reactor shield has been developed low frequency magnetic and elecatic shielding by Magnetic Shield ion, Mica Company. Unit can be orted by its own leads. Under ial conditions requiring rigid nting, eyeletting through enlarged inal opening or by clamping is ested. Elestrostatic shielding is obd by grounding. The shields are gned basically for subminiature re-s using pot type ferrite or lamid core construction. The shield is hock sensitive, non-retentive and not require periodic annealing.

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CHAMBER. A new cubic foot de, humidity, temperature test ber, interior dimensions of 3'x3'x3', eing offered by the Environmental oment Company. Standard test is −100°F to +200°F, 20 to 95% and 100,000 feet altitude. Greater ranges, cabinet sizes and acces- are available.

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TRANSISTORS. A new power transistor capable of 65 watts and 13 amps has been developed by Clevite Transistor Products, a division of Clevite Corporation. Available in the proposed JETEC power transistor package, the new Clevite transistors have been identified as CTP 1511, 1512, 1513 and 1514. They are germanium PNP types and are available with solder lugs for easier wiring. Tested to eliminate transient voltage breakdown, the transistors are capable of a current gain of 60 to 120 at 5 amps and 50 at 10 amps. The collector to base breakdown voltage ranges from 40 in the CPT 1514 to 100 in the CTP 1511; the CTP 1512 has voltage of 80 and CTP 1513 a voltage of 60.

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POTENTIOMETERS. Ace Electronics Associates, Inc. have developed a line on Change-Quick Potentiometers. Individual function cups are quickly substituted by removing the external clamp, fitting the new cup into position, two simple operations of indexing and phasing, and replacing the clamp. All cups of a seven-gang assembly can be indexed and phased in minutes, with shaft rotation alignment error of less than 0.1°.

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SEMI-CONDUCTORS. Power Sources, Incorporated, announces the new PS 4004, a military version of its Semi-Conductor Power Supply ps 4000A. Nominal input voltage of 105-125 volts A-C, 50-63 CPS, selected by a front panel switch, may be varied as specified in MIL-E-4158A. Output voltages range from 260-300 or 130-150 volts D-C. Output impedance is less than 0.1 ohm from D-C to 100 KC. Stabilization is less than plus or minus 0.05 volt on 300 volt output, and less than plus or 0.025 volt on 150 volt output. Ripple and noise averages less than 1.0 millivolt, and drift is less than .02 volts after half-hour warm up.

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

- **Missile Literature**

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

- **New Missile Products**

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

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LIQUID OXYGEN VALVES. Available is a 36-page illustrated catalog describing the valves manufactured by Airborne Research & Development Corp., Sun Valley, California, for aircraft, for aircraft and missile liquid oxygen, nitrogen and helium systems. Included are descriptions of check, filler, pressure build-up, relief, quick-disconnect, shut-off, pressure-operated and valves for special purposes made to customer specifications. Dimensional drawings accompany each valve.

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RELAY CATALOG. A new feature of the relay Sales catalog released by Relay Sales, is the list of each major relay manufacturer's entire line in alphabetical order according to the code letters and numbers. No longer need the purchasing agent or engineer look through hundreds of different type relays to find the one he wants. If he knows the manufacturer's name and relay number, he can find the relay quickly. 24 hour delivery from stock can be made on almost every relay listed.

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WIRE MARKERS. A new 8-page, 3-color catalog of pressure sensitive wire markers has been issued by North Shore Nameplate Inc. It illustrates and describes a wide variety of standard Speedy-Marx wire markers available on instant-release dispensing cards stocked by North Shore, that can be ordered quickly and easily by simply specifying the symbol or number desired. Five pages are devoted to illustrating the many categories of Speedy-Marx which are available for immediate delivery. Among them: solid numbers, letters (upper and lower case), and symbols for general use; TV markers for transmitting equipment leads and cables; solid NEMA colors; machine tool symbols; and consecutive numbers and symbols of all types.

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MODERN PRECISION. The Western Industries Edition of the Leeds and Northrup publication, Modern Precision, is now available for distribution. This 8-page tabloid contains a round-up of instrumentation applications in the far Western States. Stories are included on instrumentation at: USAF Rocket Engine Test Lab, Edwards AFB; Ideal Cement Company, Redwood City, California; Uranium Reduction Company, Moab, Utah; Boeing Airplane Company, Seattle, Washington; Colorado Fuel and Iron Company, Pueblo, Colorado; Statham Instruments, Los Angeles, California; Pacific Clay Products, Los Nietas, California; Maywood Glass Company, Maywood, California; Shockley Semi-Conductor Labs, Mountain
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views both function and facilities
each of three new SPS Screw Thr
Metrology Laboratories recently ope
by the leading precision fastener
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lustrated booklet gives the reader a
guided tour of the various preci
equipment needed for properly ch
ing unified screw threads (Classes
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(ANPT and NPTF) as well as spe
precision thread forms. A seven-p
appendix of reference material extr
pertinent data on screw thread dir
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DELAY LINE. Catalogue DL-78 of
Digitronics Corp. describes results
improved design in construction
DYKOR lumped constant and cont
ously variable delay lines. This 4-p
brochure lists parameters of stand
lines showing exceptional figure m
indicating high delay/rise time/num
of sections ratio. Description also
cludes characteristics of infinite res
tion continuously variable lines. T
nical details are given on delay,
time, attenuation, impedance, temp
ture coefficient, tolerances.

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MATERIALS FOR HYPERSON
WEAPONS. A 16-page booklet by
Steel Improvement and Forge Comp
describes the forging materials av
able for aircraft and missile struct
parts, classified for various speed
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by Skyvalve, Inc., gives comprehen
data on high-pressure hydraulic
pneumatic valves for aircraft miss
and rockets. Dimensional drawings,
charts, and production test specif
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76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125
126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150
151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175

• • **Missile Literature**

200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224

• • **New Missile Products**

225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249
250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274
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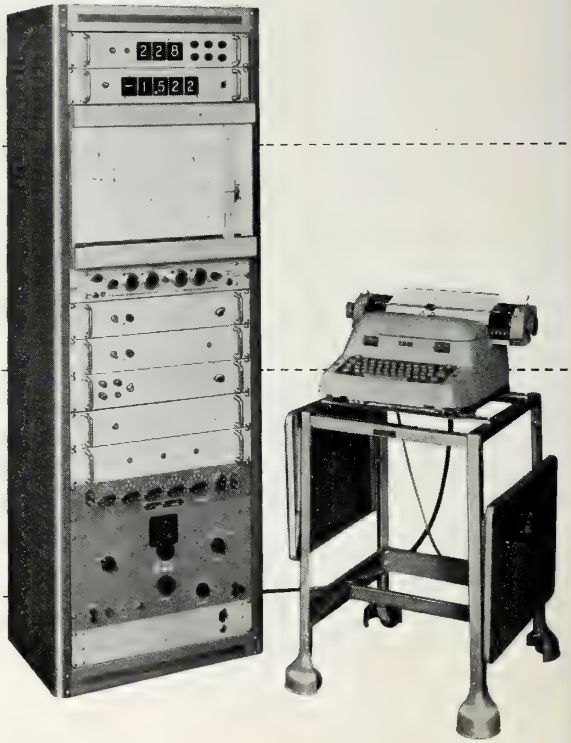

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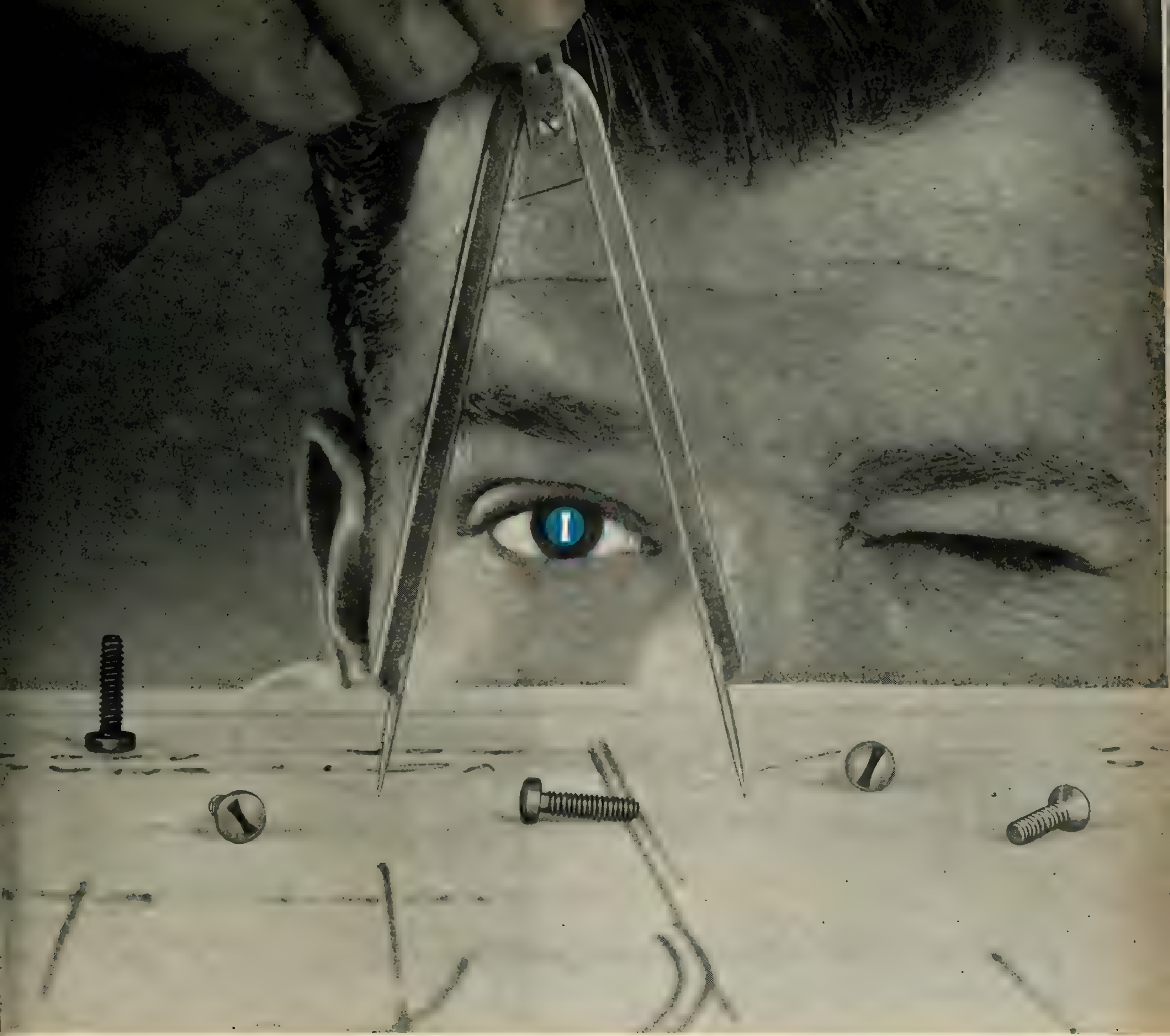

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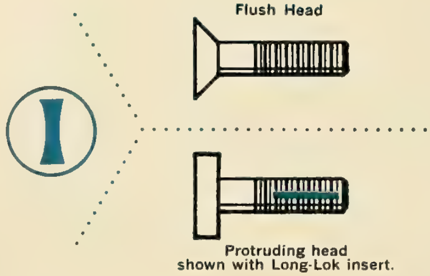

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COVER: *Total eclipse of the sun photographed by a team from the U.S. Naval Observatory at Canton Island on June 8, 1937. Yesterday's total eclipse was observed by a U.S. IGY team from a boat in the vicinity of the Danger Islands, between Samoa and Tahiti. Groups of* Nike-Asp *rockets were sent up before, during, and after the eclipse to aid IGY scientists in observation of X-ray radiation from the sun. (See Story p. 16)*

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in this issue

OCT. 13 HEADLINES

First of 60 IRBM Missiles Reach England
At least one *Thor* squadron will be operational in 1958, under British control, but RAF feels vehicle is untested 13

Tests Find Anti-Lox Materials
Martin Co. engineers use shock treatment to determine explosive factors, reports propulsion specialist Zaehringer 14

Rockets Used to Test Eclipse Phenomena (cover story)
Nike-Asp series, fired from shipboard, check origin of X-rays, other scientific data 16

U.S. Being Forced to Face Up to Engineer Shortage
Demands of missile technology, as well as general upswing in use of engineering knowledge, sharpens short supply 19

Formosa Forces Well Equipped with Missiles
In a special report to m/r from Taipei Correspondent Frank Huntley outlines armament available 48

Second Moon Probe Geared to Measure Radiation
Extent of the radiation belt, newly discovered by satellites, will be a major objective of newest attempt 45

NASA Begins Operation With Key Appointments 24

MISSILE ELECTRONICS

Global Group Formed to Perpetuate IGY Work
Washington meeting results in formation of organizations to study means of continuing IGY studies on world-wide basis 37

Sun May be Used for Cooling Spaceship
New studies of Peltier refrigerator effect may provide answers to problems in spaceship construction 39

GE Continues Streamlining Electronics Division 43

Personnel Remains Chief Electronics Industry Problem ..43

DEPARTMENTS

In My Opinion 6
Washington Countdown .. 9
Industry Countdown 11
Propulsion Engineering .. 33
Missile Business 35
Contract Awards 35
Missile People 50

In My Opinion . . .

. . . The U.S. Army now faces the greatest space age challenge yet, lunar space construction. But unless Army leaders do something about it soon, the role of the Army is likely to fade away quickly in the space era.

Many Washington officials now admit we must begin to think sincerely about establishing lunar bases. This kind of research and construction task—traditionally and logically—is a job for the U.S. Army Corps of Engineers. With its vast experience and with the backing of the Signal Corps and the Missile Ordnance Command, the Corps of Engineers should establish a special research group for space base development. Working closely with industries in the architectural-engineering area, plans should be made now for our first automatic military lunar stations.

These, obviously, will be small packages in the beginning, but within ten years they will become bigger and will contain manned observers. It should not b necessary at this point to repeat anything about how hard Russia is pushing he lunar base program. In this base research area, in spite of great enthusiasm on th part of such outstanding planners as Brig. Gen. Homer A. Boushey, who repeatedly has stressed the importance of the use of lunar bases for retaliatory purposes in a future war.

The Corps of Engineers must act now to get the blessing of Lt. Gen. Arthu G. Trudeau, Chief, Research and Development, and move ahead, possibly funde by ARPA.

The Army has suffered badly from poor public relations in the missile program. Army's loss to the USAF in the IRBM roles and mission battle was mainl a result of poor public relations planning. McElroy's modification of Wilson' stubborn ruling limiting the distance of Army missiles is proof enough. The old time Army conservatism will not get the soldiers anywhere in the space race. Th Air Force now is advancing at full speed to become the No. 1 service in th space age. One year ago a directive was circulated among top AF officials ordering them not to imply in speeches, press releases, etc. that the USAF was pushin space flight. The word space flight was not to be mentioned. Today,—three-sta USAF generals hint the Air Force some day will become the U.S. Space Force.

This should convince Army leaders that change-overs and breakthrough constantly will take place. What was good yesterday may not be so good to morrow. The Army certainly must show more vigor and foresight if it expects t take an active part in our conquest of space. We do need the Army in this bi struggle. But Army leaders must wake up and do something about it. A luna base research and development program must be started now. And industry mu be invited to participate.

Erik Bergaust

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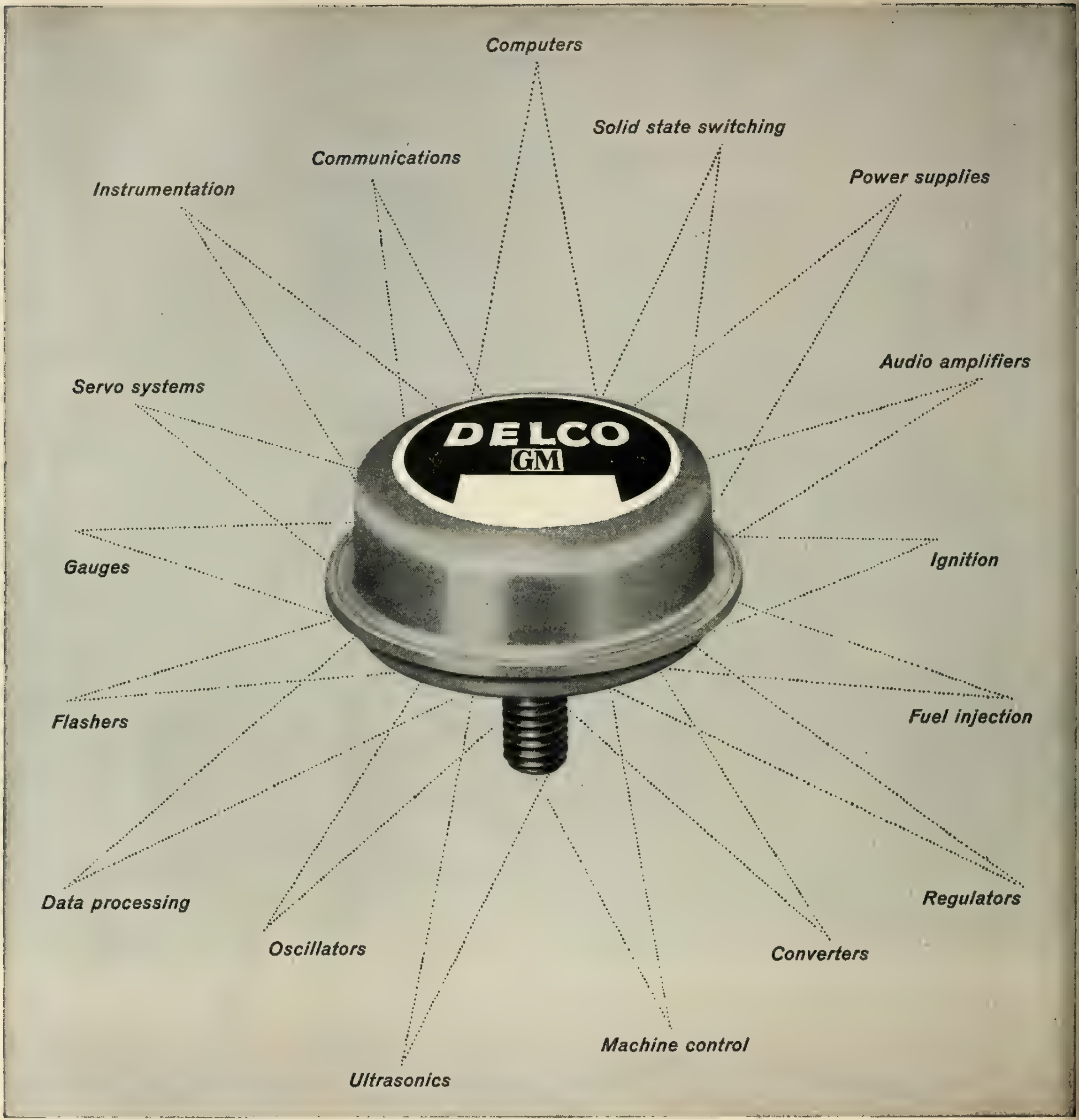

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washington countdown

Washington rumor . . . that Army Ordnance Missile Command's scientific talent under direction of Dr. Wehrner von Braun would be transferred to administration under NASA, was neither confirmed nor denied by AOMC's Maj. Gen. J. B. Medaris and Washington sources, including Dr. James Killian, the president's scientific advisor. No transfer of personnel is reportedly involved, but sources said NASA has reached—or is about to reach—an agreement with Defense Secretary McElroy approving the administrative change. Such change could be made only by presidential executive order.

Better protection . . . for proprietory rights, patents, etc., is afforded by a just-issued Armed Forces Procurement Regulation, Part 2, Section 9. The revised AFPR limits the amount of technical information a company is required to divulge to competitors.

The scientific mind . . . sometimes dreams up titles reminiscent of New Deal days in Washington. The recent International Committee of Scientific Unions' conference list included SCOR (Special Committee on Oceanic Research), SCAR (Special Committee for Antarctic Research), COSPAR (Committee on Space Research) and CETEX (Committee on Contamination by Extra-Terrestial Exploration.)

Greater efficiency . . . and maneuverability of the Ballistic Missile Division's handling of space projects is the reason for the new Ballistic Missile Systems Office. When BMD was set up that's all it dealt with—ballistic missiles. Evolution of the art has resulted in true space vehicles and two separate deputies for Gen. Schriever.

Rep. John E. Moss . . . (D-Calif) has accused the Air Force of withholding a report, "Survey of Management of the Ballistic Missiles Program" from his House Information Subcommittee. Consequently Moss has ordered an investigation even though Air Force Secretary James H. Douglas announced that the release of the report would have a serious adverse effect on the department. Moss charges that the situation is intolerable when a federal agency is allowed to throw a cloak of secrecy over possible mismanagement.

'No great concern' . . . was the comment of NASA Administrator T. Keith Glennan when he was asked the delicate question recently on how his agency can pursue the things it wants to without restrictions from the military. Glennan replied "I am very naive and very optimistic." Evaluating U.S. progress in the so-called first year of the space age, Glennan expressed the belief that "progress has been really substantial."

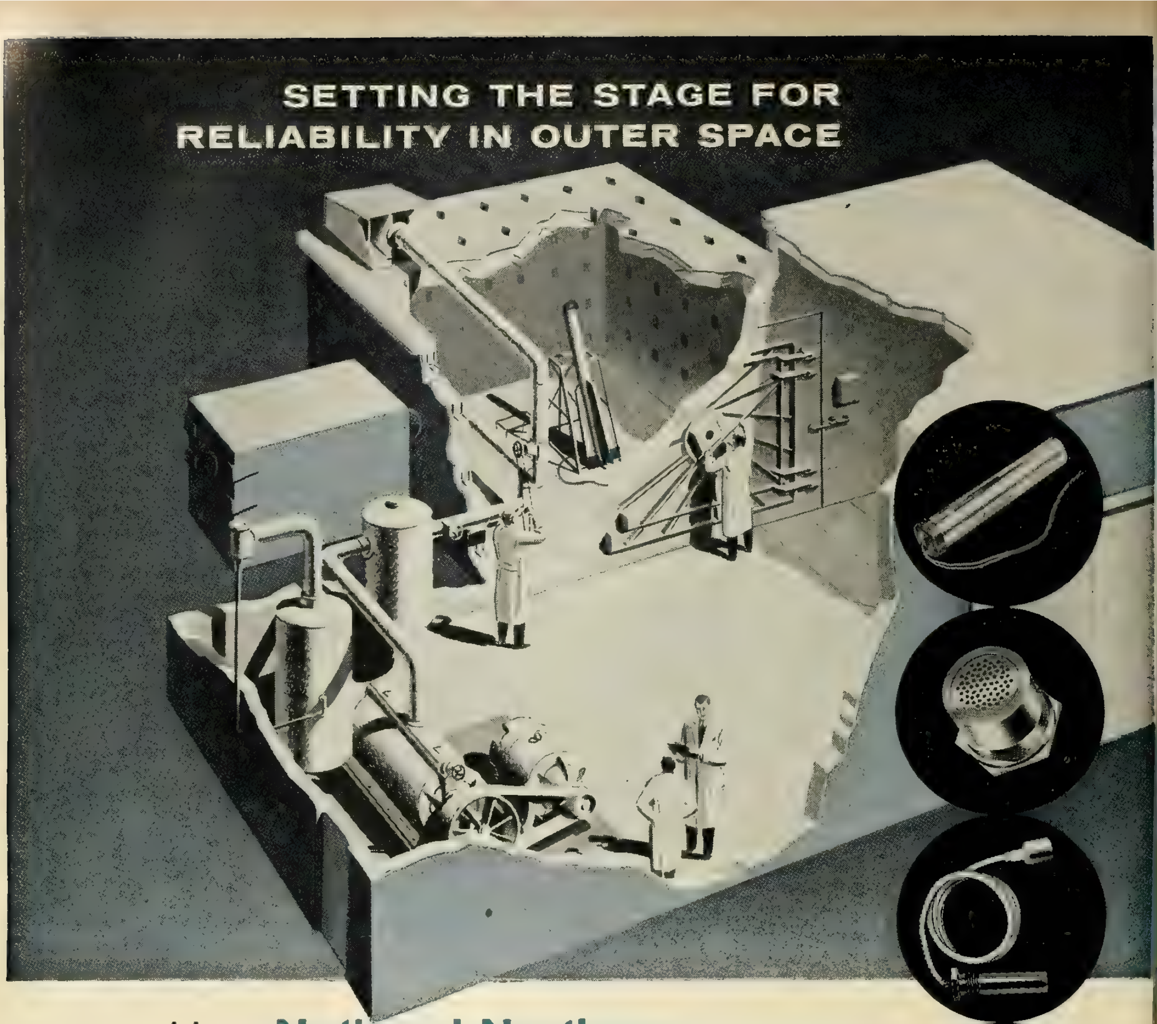
Successor to *Houndog* . . . may be in works judging from comment recently of Lt. Gen C. S. Irvine who said an air-to-surface guided missile "perhaps for the B-52 and most certainly for the B-70" had been proposed.

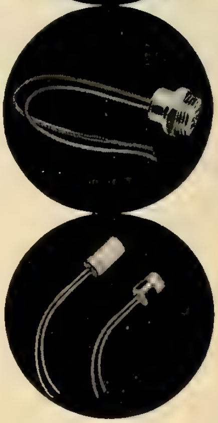
The Air Force . . . will put its planes and missiles on parade October 20-30 at the sixth annual Weapons Competition. Tactical fighter phases will be run at Nellis AFB, Nevada. Interceptor phases will be run simultaneously at Tyndall AFB, Fla. There is a report that industry planes will televise a high-altitude air-to-air missile intercept.

The steady stream . . . of contracts involving *Jupiter* continued this week as the Army announced four more totaling $6.5 million. The majority of such small contracts are for service, support and personnel required.

Navy scientists . . . set a new record when a 1,600 pound ASP rocket with a *Nike* booster climbed to 152 miles from the LSD, USS Point Defiance in the South Pacific near the site of the IGY Solar Eclipse Expedition. It was the first shipboard *Nike-Asp* launch and a record altitude for ship-launched rockets.

SETTING THE STAGE FOR RELIABILITY IN OUTER SPACE





How National Northern assures dependability in high altitude performance of ignition devices, pyrotechnics, and explosive components.

As depicted here by the artist, National Northern technical experts prepare their high altitude test chamber built in cooperation with the U.S. Navy, for surveillance studies to determine how extremes of temperature and pressure affect the performance of explosive charges. Through exhaustive environmental tests like these, National Northern Division of American Potash & Chemical Corporation can assure you of "built-in reliability" for the vital performance of propellants for rockets and missiles, explosives, pyrotechnics, detonators, igniters, squibs, gas generators, fuses, and related items. Years of experience in research, development, and production of literally thousands of these components for leading defense and commercial customers is the reason why National Northern should be your first choice for a solution to your problems in the design and production of packaged pyrotechnic and explosive components. Write today for your copies of National Northern's current technical bulletins and facilities brochure—"Missile and Rocket Power Technology." Address National Northern Division, American Potash & Chemical Corporation, P. O. Box 175, West Hanover, Massachusetts.

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TRACERS AND INCENDIARY ELEMENTS • DESIGN OF ELECTRIC DETONATORS AND SQUIBS • AIRCRAFT VULNERABILITY TESTS AND EVALUATION • EXPLOSIVES METAL FORMING • BORON PELL

industry countdown

Small solid propellant rockets . . .
will be used in the *Nike-Zeus* anti-missile missile system for generating auxiliary power for the weapon's hydraulic and electrical system. Garrett Corp., producer of the units, is working under subcontract to Douglas Aircraft, one of the recipients of the recent million contract for further R&D on the *Zeus* system.

Douglas Aircraft is currently . . .
in the second phase of a far-reaching engineering realignment program for greater utilization of the company's increasing missile and space systems activities. Douglas, Martin and Lockheed are currently the top three (percent of individual income) prime contractors in the missile industry.

Another example of the diversified expansion . . .
of the missile industry is exemplified by the recent contract released to the Universal Match Co. for component manufacture for the Navy ASROC missile. The anti-submarine rocket, produced by Minneapolis-Honeywell, is similar to the RAT rocket launched torpedo.

With odds in favor of the *Thor* . . .
over the *Jupiter*, when the selection between the two is made, production of the Army-developed missile is expected to continue until at least three or more squadrons are available. Decision is expected sometime in November after completion of the intensive study now underway. Meanwhile, Chrysler has received an additional five Army contracts totaling $4.9 million for *Jupiter*.

The *Bomarc* area defense missile system . . .
which could easily top $2.5-billion before the planned program is a reality, has been accepted by Canada as a replacement for the Avro *Arrow* supersonic fighter. The *Arrow*, equipped with air-to-air *Sparrow* missiles, is currently Canada's major air defense. Canada wants to produce the Boeing missiles under license by Canadian firms.

If confidence will win contracts . . .
Boeing is well on the way to obtaining the *Dyna-Soar* weapon systems award. Boeing recently assigned two pilots from its Seattle Division for first tests of the boost-glide vehicle. An official from one of the competitors was overheard to say that the selection of the sons of present-day pilots as test personnel would have been more apropos.

The long sought after . . .
Special Civil Air Regulation from CAB authorizing the CAA Administration to take into consideration rocket engine standby power for transport aricraft has been adopted. This regulation will permit aircraft a higher maximum weight when equipped with either liquid or solid propellant rocket assist take-off units.

Accessory power development . . .
is showing a definite trend toward complexity, with the result that future advanced vehicles may well be limited by development trouble of accessory powerplants, rather than of main propulsion systems. These development problems wil have the spotlight during this year's 8th Annual Aircraft Hydraulics Conference to be held in Detroit Nov. 12-14. A special report on the design complexities of the *Dyna-Soar* and *Minuteman* systems is expected to draw considerable attention.

Sometimes technical competence . . .
is overshadowed by engineer presentation capabilities. Although in most instances the technical capabilities decide the selection of the contractor, a top R&D official of the Air Force stated that many companies lose out during competitive studies as a result of poorly written presentations. This is especially true during some project assignments by top level personnel with administrative instead of technical backgrounds.

Sperry Rand's new $3-million . . .
electronics facility constructed to expand supply of advanced radar and missile instrumentation has been tabbed the Sperry Microwave Electronics Co. The facility is currently producing *Jupiter* ground support equipment.

A Senate military procurement . . .
subcommittee has recommended that an investigation be conducted to determine the reason for the decline in subcontract percentage awards in the Navy *Bullpup* hardware production. The recommendation was very critical of the Bureau of Aeronautics handling of small business awards and the general DOD policy toward the smaller firms.

Well done, Nautilus...well done, Skate

We were proud to be aboard for your historic voyages through the uncharted waters beneath the Polar ice...proud that our Inertial Navigation System helped to make them possible. This system was the outcome of our 12 years of research and development in inertial navigation for the Air Force. The results of your superb seamanship are helping us to advance the art to even higher standards of precision. We are now building the extremely accurate and reliable systems for the first of the Navy's new generation of atom-powered submarines that will be armed with the Polaris missile.

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OCTOBER 13, 1958
VOL. 4, NO. 15

missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

First of 60 IRBM Missiles Reach England

First *Thor* Squadron "Operational" by end of '58 Under RAF Control; British feel vehicle untested

RAF STATION, LAKENHEATH, ENGLAND—*Thor* Intermediate Range Ballistic missiles are arriving steadily and on schedule at this big RAF airdrome, destined for IRBM bases which are being constructed along the East Anglia coast.

They arrive in USAF C-124 Globemasters and are off-loaded to special lorries which transport them to nearby firing sites. The first *Thor* appeared in August. A total of 60 is programmed to make up the full four IRBM squadrons in England. The first will be "operational" by the end of the year.

Feltwell is the site of the first major IRBM installation. The location of others is protected by security, as are the exact details of deployment.

There probably will be, m/r has learned, four major sites, one to each squadron, with possibly four "satellite" firing pads clustered around the "mother" installation. Each pad will have three missiles on location.

In rotation, one missile will be on alert firing status at all times, with the other two in a somewhat lesser ready state. When operational the situation will be about as follows:

- **Guidance**—Each missile zero-ed in on a pre-selected target.
- **Fuel**—Alert missile partially fueled, and counted down to about 30 minutes, with high hopes of reducing this time as skills and familiarity increase.
- **Warhead**—Stored nearby and under U.S. control as required by law, but not too far away to delay operations once the word should be given.

British IRBM Bases Necessary

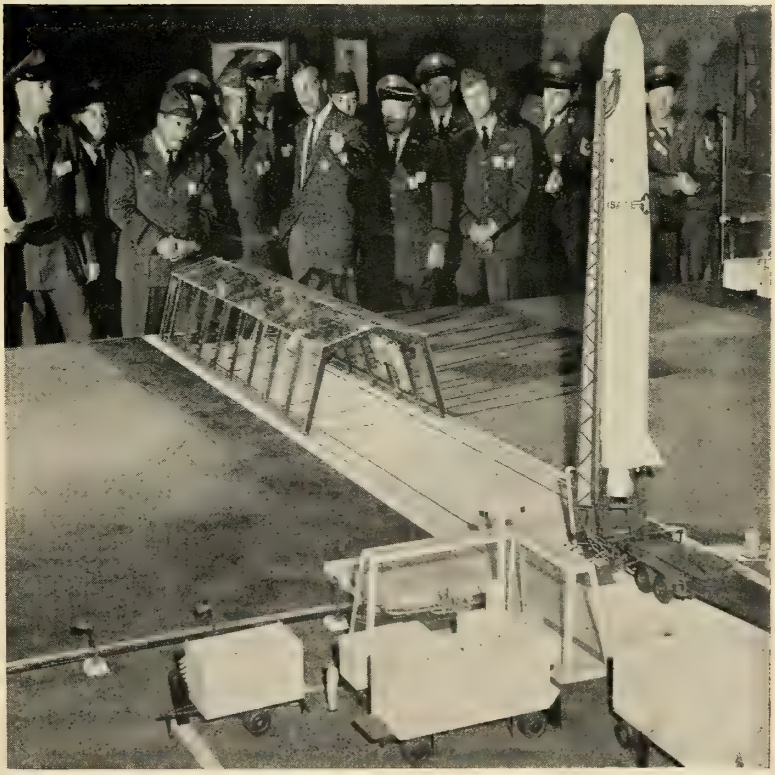
Under original plans, when the agreement was signed to station American-made IRBMs in England, two U.S. squadrons of airmen commanded by USAF officers were to be sent to Great Britain. They would set up the first installations, position the missiles and operate them. Some RAF missile men were to be trained in America, others on the job in East Anglia. As they became proficient they would be phased into the American squadrons and, at some later date, would staff them fully. Details of manning the second two squadrons were left fluid, depending on RAF training and proficiency.

Her Majesty's loyal opposition, the Labor Party, however, got wind of this and fairly raised the roof of Parliament. Was England to permit Americans to man ballistic missile bases on their island from which—conceivably—atomic weapons might be fired without—again conceivably—Britain having any control in the matter? Understandably, a great many Englishmen didn't like this and there followed considerable backtracking.

The United States gave in gracefully. A great deal more than the command line was at stake. The British press was already raising a storm about SAC's bombers over-flying England and had to be reassured they weren't carrying nuclear weapons on practice missions. Having IRBMs in England was an important part of the strategic deterrent plan, and—just possibly—England might have a point. Now, with England firing the missiles and America holding the warheads, dual control becomes obvious.

Training was stepped up and now, the squadrons manning the missile pads are Royal Air Force squadrons, both officers and other ranks. There are American advisors, American technicians, both in and out of uniform, helping. But the command line is British, direct to Air Marshal Sir Harry Broadhurst, Chief of RAF Bomber Command. USAF Col. Harry Zink, originally one of the squadron commanders, is serving as on-scene advisor.

(Continued on following page)



MISSILE AIRMEN TRAINEES see a miniature scale model of the *Thor* IRBM firing pad, hangar and support material.

England: A Little Dubious

The British are viewing the entire operation with some uncertainty, based largely on two points:

1. They feel the *Thor* is still insufficiently tested.

2. They feel that reaction time is too great—that it could easily take longer to fire a salvo of *Thors* than the warning time Britain might have of a Soviet missile attack.

In addition, they worry because the missile must be largely serviced from a horizontal position and fired, of course from a vertical posture; that the sites themselves cannot be hidden and will not be hardened, leaving them extremely vulnerable as far as location and attack is concerned.

But, with all, the British view these matters realistically, knowing that their own *Blue Streak* is not even in the hardware stage, superior as it may look on paper (a 2,000-mile solid fuel missile, firing from a hole in the ground, similar in the last two respects to the USAF's projected *Minuteman*).

Word of the first *Thor*'s arrival and location of the first site at Feltwell broke, oddly enough, from Amsterdam to Lord Beaverbrook's ebullient Daily Express. Previous to that time, although the London press knew in fair detail what was going on missilewise, they were held in check by a Defense of the Realm Act. This is an arrangement whereby the government can simply warn English publications that thus-and-so story is off limits. The press bows.

Thus when the Daily Express broke the story from Amsterdam during the International Astronautical Federation meeting there, it was generally understood to be via a very high intentional leak. The government ignored the Express's full page spread on the *Thor* and its English bases for several days and then releasead an official announcement very routinely. Other papers picked it up. Little more has been said.

The Americans, for their part have come to be pretty relaxed, too. The giant *Thors* arrive in England bare, ready for the Royal Air Force markings, which are immediately stenciled on.

SAE Discusses Missiles

Transportability and mobility of missiles were the center of a day-long discussion, as the Society of Automotive Engineers turned its attention to missiles at a recent Los Angeles meeting.

Ground and air means of transporting missiles must be studied anew, according to Ron Stoner, Missile Space Engineering Division, Douglas-Santa Monica.

Tests Find Anti-Lox Materials

Shock Treatment Used by Martin To Determine Explosive Factors

by Alfred Zaehringer

BALTIMORE—Results of impact sensitivity tests conducted in the Materials Laboratory at The Martin Company's Baltimore Division reveal the following materials which when saturated with LOX and subjected to shock would explode:

1) Synthetic elastomers and Thiokols.
2) Cellulose based papers.
3) Silicone and silicate based oils and greases.
4) Thermo-plastics such as nylons and phenolics except pure uncontaminated Teflon.
5) Thermo-setting resins such as phenolics, silicones, epoxies, etc.
6) Petroleum based oils and greases.

This work was extremely important since seals and gaskets subject to LOX contact would often detonate when subjected to surge impact. Spillage of LOX on asphalt was also dangerous since the asphalt would also explode when inadvertently stepped on.

In 1957, meetings were held at Ramo-Wooldridge Corp. by the LOX Lubricants Standards Committee to develop interim specs on LOX-compatible materials. Martin-Baltimore carried on impact tests to screen suitable materials.

The tester used consists of a guillotine impact tester, with a 71.75 pound weight falling through a distance of one foot. A stainless steel hammer mounted on the weight transmits the impact force to a striker resting on a sample of the material being tested in an aluminum sample cup.

The weight is dropped by a quick-release mechanism actuated by a solenoid. Materials were ½-in. squares 0.05-inch thick. The test cup with test specimen was filled with LOX and additions of LOX were made until boiling ceased, then subjected to impact.

Some 63% of the materials tested were impact-sensitive. Of these about 75% were moderately to extremely sensitive. Materials were classified for all future rocket or ground support systems used in or near liquid oxygen:

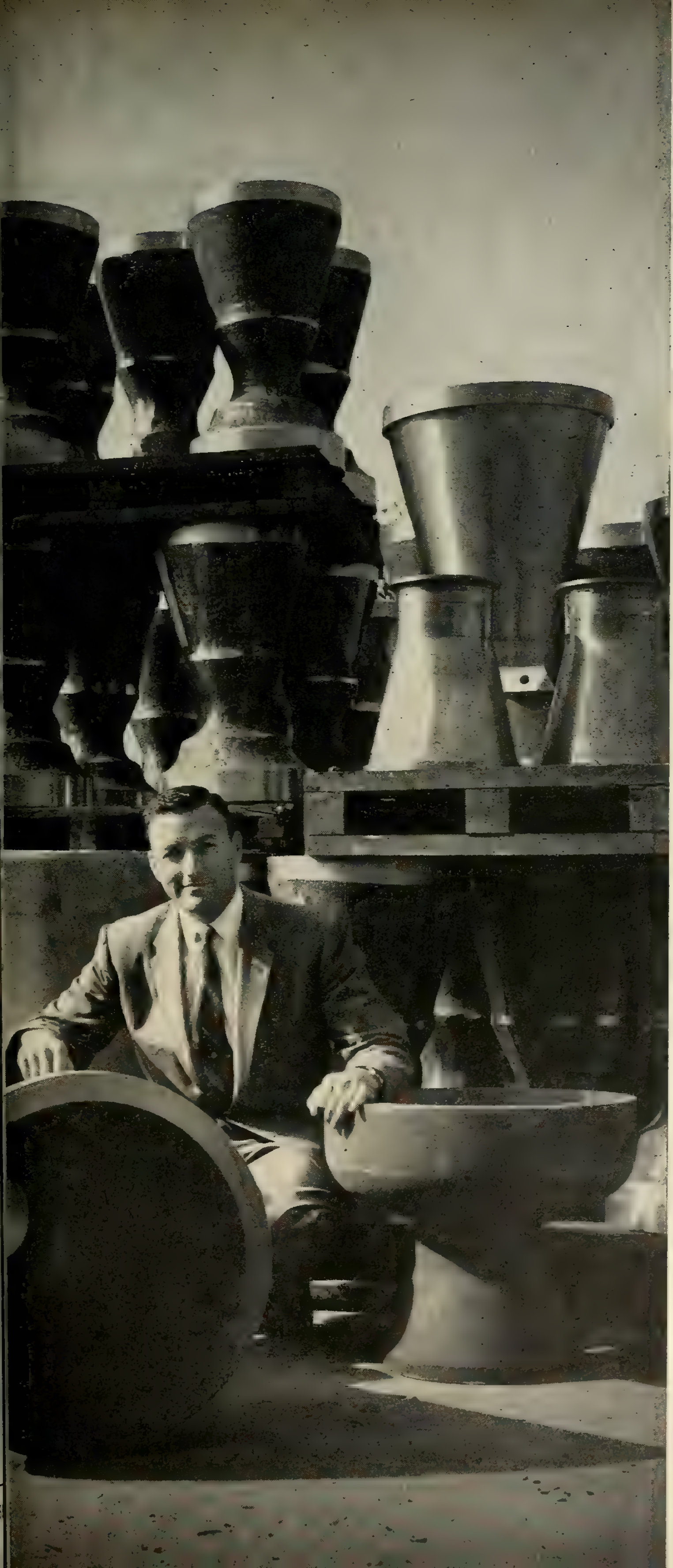
1) Materials acceptable for use in liquid oxygen systems and areas subject to liquid oxygen spillage. (See table below).
2) Materials acceptable for limited use in areas of liquid oxygen spillage.
3) Materials rejected for use in liquid oxygen systems or in areas of liquid oxygen spillage

Acceptability was based on one detonation in 40 impacts or none in 20 impacts. The intensity of the detonations was very audible in all cases Those of lower magnitude were similar to the sharp crack of a .22 caliber shell, while those of greater magnitude sounded like a .50 caliber shell. The latter was obtained on most petroleum products.

The work was reported by D. E Clippinger and G. J. Morris of the Materials & Design Support Department. For listing of unacceptable materials plus specs on acceptable materials, contact Martin directly.

Materials Accepted for Use

Material	Use
Fluorocarbon Grease No. 3&4&5	Lubricant & Anti-Seize Compound
LOX lubricant (graphite & halogenated biphenyl)	Lubricant & Anti-Seize
Fluorocarbon Oil	Lubricant
Moly Disulfide Powder (MIL-L-7866)	Lubricant
Solid film lube, sprayable, air dry	Lubricant
Ceramic impreg. polytetrafluoroethylene gasket	Gasket
MIL-H-5606A Hydraulic fluid (Unoxidized & unfiltered)	Hydraulic oil to 250°F
Pure polytetrafluoroethylene	Gasket, insulation, potting molds, connectors
Polytetrafluoroethylene water base compound. MCI-20201	High pressure thread compound to 6,000 psi
Polyethylene sheet MCI-15014	Chemically inert material
Wire, Wrapped & Extruded, fluoroethylene, NAS 703	High temperature wire insulation



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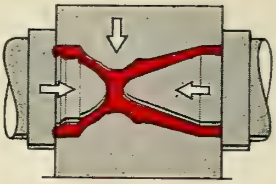
A better nozzle for less money has put Cameron way ahead in production of these important missile parts. Cameron's exclusive split-die forging process makes this possible. Each nozzle is forged from a single heated billet of specified steel. This steel is produced in Cameron's own melt shop under the closest possible control. From these perfect billets our specially designed split-die presses forge a near final shape.



Movement of the three elements in the split-die process.

No welds are required and machining is greatly simplified—grain structures are perfect.

Missile nozzles produced by this method are supplied as finished forgings ready for economical machining or completely machined to specification. At every single phase of manufacture, each nozzle is checked by the most modern methods used today.

The Cameron split-die process has successfully solved many unusual forging problems in a wide variety of end uses. Some of these include critical airframe members, jet engine components, propeller blades and hubs, atomic reactor valves and many high pressure controls for the oil industry.

Cameron has extended the great advantage of ferrous forged members to include shapes impossible to produce heretofore. Present production of missile nozzles includes diameters to 28″ with large open sections and elongated double conical thin sections to 36″ in length. In weight our forgings range to 8,000 lbs. and our high quality alloys satisfy many unusual demands. If you need forgings in this group and, of course, if you need nozzles, call, write or come by . . .

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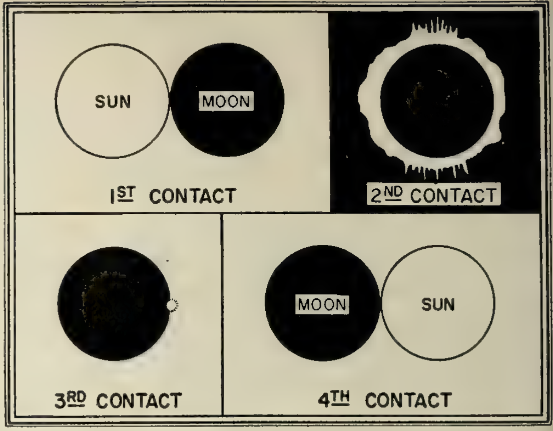
P. O. Box 1212, Houston, Texas

Rockets Seek Data on Eclipse Phenomena

Nike-Asp series, fired from ship in mid-Pacific, may add to information on X-rays, other data affecting Earth

by Raymond M. Nolan



As m/r went to press, a group of American astronomers and physicists were cruising the Pacific Ocean near the island of Pukapuka in the Danger Islands, waiting to fire six or possibly eight *Nike-Asp* rockets before, during and after the Columbus Day (Oct. 12) eclipse.

The men are members of a Naval Research Laboratory team headed by Drs. H. Friedman, T. A. Chubb, and J. C. Lindsay. They are studying the distribution of ionizing sources on the sun's disc and in the corona by direct measurement from the rocket.

NRL planned to fire a series of six to eight rockets during the eclipse—two during the period of totality and the rest during the partial eclipse before and after totality. Each rocket was equipped with detectors for soft X-rays, harder X-rays and Lyman-Alpha ultraviolet radiation. Data recorded during the rocket flights was to be telemetered to receivers aboard the USS Point Defiance (LSD-31).

The task was made harder because Pukapuka is so small that the rockets had to be fired from the ship in order to keep from interfering with or disturbing the measurements of other equipment situated on land.

• **Flight trajectory**—The 210 lb. *Asps,* built by Cooper Development Corp. of California, were to be boosted to about one mile by *Nike* boosters. Then they were expected to coast for 13 seconds before ignition and climb to the target altitude of from 150 to 180 miles. These were to be the first *Nike-Asp* firings from shipboard, with each *Asp* in flight for about seven to eight minutes—about five minutes of which was above the absorbing ionosphere.

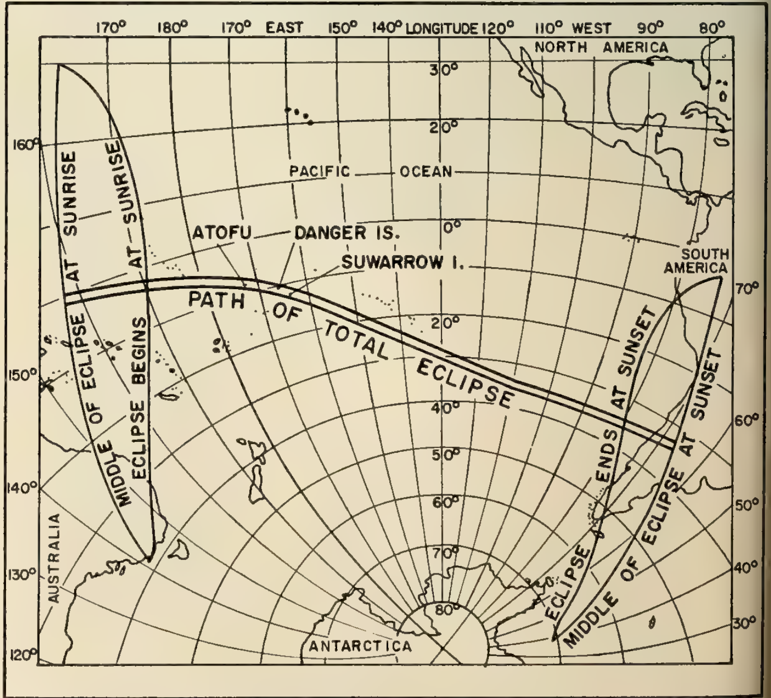
Totality of the eclipse is about four minutes—during which most of the phenomena occurs. Plans were to have two *Asps* in the air throughout totality.

Launchings were to be made in quick succession between first and second contact (see above sketch), just before second contact, and between third and fourth contact.

• **Origin of X-rays?** Measurement of X-ray radiation by the rockets when they are well above the ionosphere, might enable scientists to determine whether the X-rays, which produce the ionosphere, are the result of the so-called green clouds on the sun.

The green patches—created when particles from the sun reach high velocities circumventing sunspots and bombard iron atoms in the corona—may be the source of the ionizing X-rays, although no proof exists. The NRL team, with rocket measurements, and cooperating teams taking photographs of the sun during the eclipse, will attempt to determine if the rays really do come from the green clouds.

Other institutions participating in the expedition are the Central Radio Propagation Laboratory of the National Bureau of Standards; University of Wisconsin; California Academy of Sciences; U.S. Naval Radiological Defense Laboratory; Sacramento Peak Observatory; and the High Altitude Observatory of the University of Colorado, under AF sponsorship.



PATH OF TOTALITY of eclipse of October 12, 1958 and location of observation sites.

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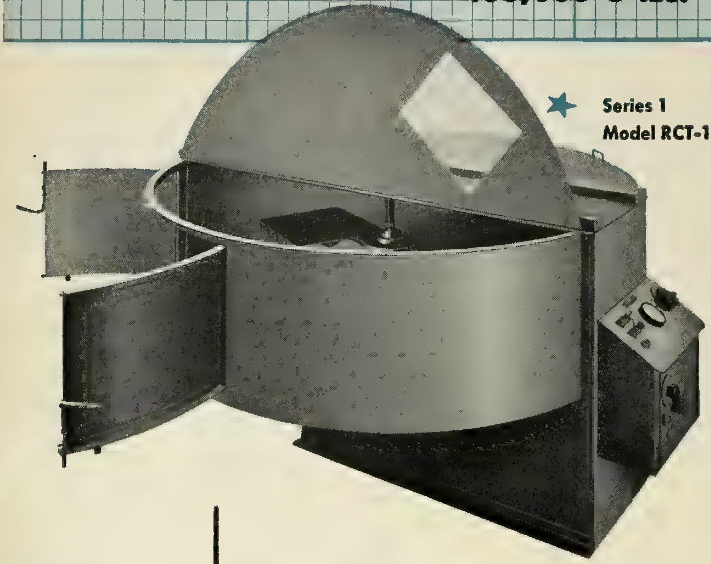
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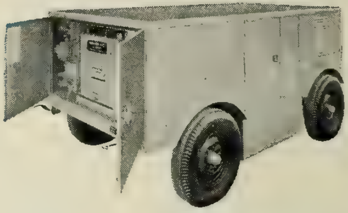

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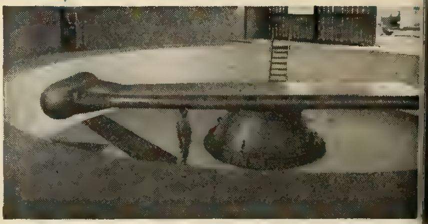


View of 22′ radius arm and power-head installed in test pit. This large Series 20 unit is designed for testing 4,000 lb. specimen at 100 G-rating.

Need Forces U.S. To Face Engineer Shortage

Demands of missile technology bring greater pressure for solution; some action started, but slow results

by Erica Cromley

There are 85 times as many jobs for scientists and technicians in the United States today as there were 80 years ago. But there are only five times as many workers in the total labor force.

Although an increasingly larger percentage of the work force goes into science and engineering, the scientific-manpower supply, hit hard during the Korean war, continues to be short.

An increasingly large percentage of newspaper "help-wanted" columns are appealing for skilled help. On one recent Sunday, the N.Y. TIMES ran 728 individual ads by missile, aircraft and electronic companies for engineers and scientists, the majority listing multiple openings. Of these, 253 were for electronic engineers. Salaries listed ranged between $9,000 and $15,000, with a few going to $25,000.

The scramble for top-drawer technicians from comparatively slim available supplies has forced industry to bid up pay rates, add fancy fringe benefits, resort to "body snatching" from one company to another. It has brought pressure on government and education to find answers.

While some existing U.S. government programs were stepped up and budgets increased after *Sputnik* was launched a year ago, the only dramatic, significant action by the government was the National Defense Education Act of 1958—and that had rough going. In place of the nearly $100 million for scholarships, Congress compromised on student loans, although in the past such available loan money has had comparatively few takers.

Industry also has been stepping up its own training and education-aid programs for some years.

• **Outlook dark**—There is today a sufficient number of run-of-the-mill technicians and engineers; a shortage of top-notch, creative men—both those with broad, well-rounded engineering backgrounds and those in certain specialties. However, indications are that in a few years industry may find both top and bottom rungers in short supply.

The Scientific Manpower Commission reports an "acute shortage" in these fields: electronics and electrical engineering, mechanical engineering, physics and mathematics; a "moderate shortage" of chemical engineers and chemists.

The U.S. Employment Service's Professional Service, a "last resort" for industrial recruitment, recently reported 1,700 openings for electronic and electrical engineers, 1,650 for mechanical engineers. This is considered only a small fraction of the total demand, since the vast bulk of industrial hiring is done through the companies' own personnel recruitment programs and through professional societies.

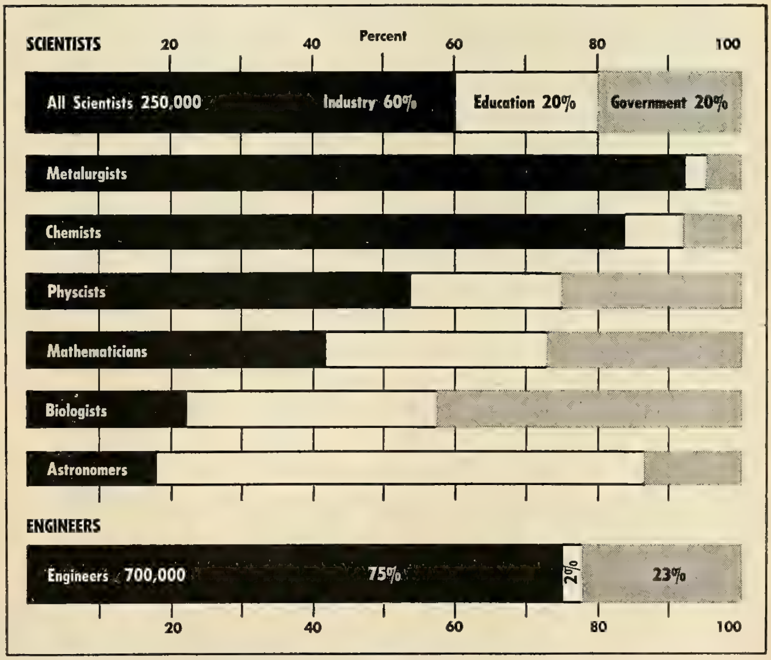
• **Getting worse**—Although the engineering ranks swell each year, the President's Committee on Scientists and Engineers predicts continuing problems for the next ten years. Skilled help needs will increase because the population is increasing at the rate of 3 million a year, the standard of living is expected to go up, and continuation of the cold war means continuation of sharp economic competition.

While the demand goes up, the problem will be compounded by the lower reservoir of young manpower brought on by the skimpy birth rate of the depression. This "lean generation," now being graduated, will not begin to fill the skilled-labor gaps. By 1965, there will be 700,000 fewer men between age 25 and 34 than there are today.

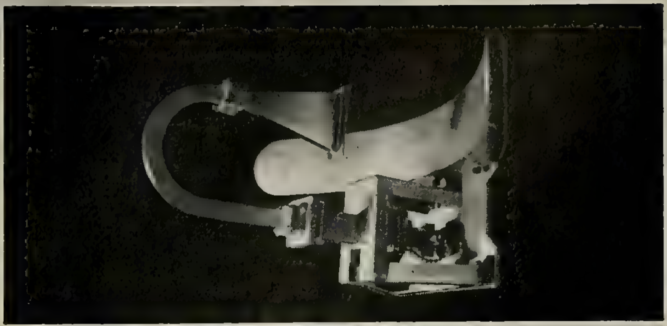
U.S. problem is one of education

In the *Sputnik*-spurred reappraisal of its educational system, the world's most technically advanced nation can find small comfort for the future:

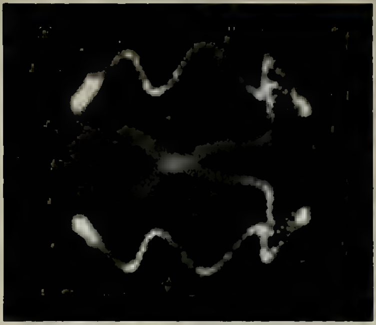
We graduate 34,000 engineers annually to Russia's 80,000. Soviet secondary school students get five times more hours of science and math than required for entrance to a top-notch American college. Fifty-three percent of a Russian student's school year is devoted to science, while a recent survey shows that less than 1/3 of our high school praduates had taken one



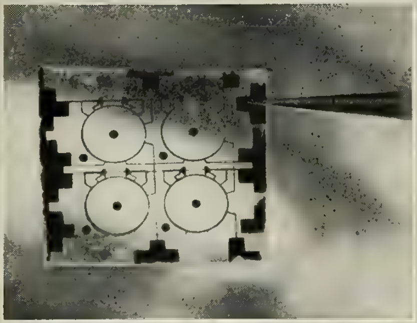
MAJORITY FIND EMPLOYMENT in industry in most engineering fields.



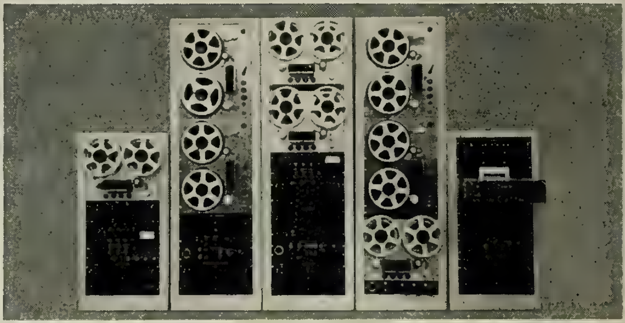
Horn fed parabolic reflector antenna for airborne applications.



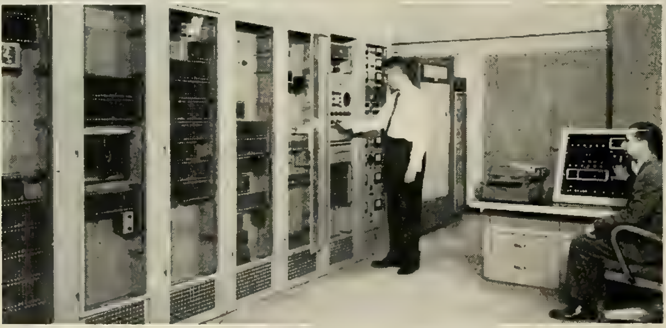
Charged aluminum particle suspended and controlled in a vacuum chamber by an oscillating electric field.



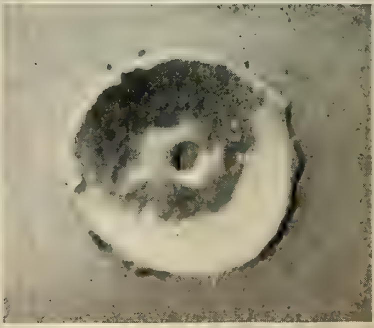
The Persistor gives promise of cryogenic computer memories with a capacity of 1,000,000 bits per cubic foot and access times of 1/30 microsecond.



Ground based data handling equipment for processing analog and digital reconnaissance information.



Data conversion system for digitizing and processing telemetered missile test data.



Electron micrograph of impact produced on aluminum coated glass by a 1 micron diameter particle traveling at 7,000 feet per second.

Pictorial **PROGRESS REPORT**

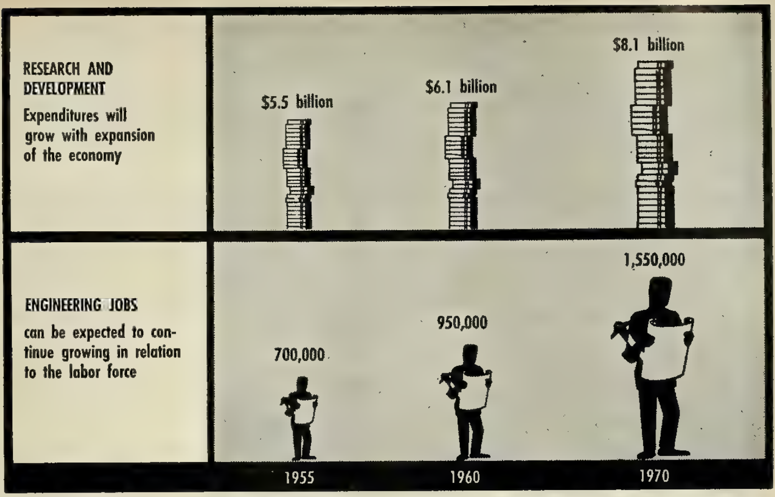
The photographs above illustrate some of the recent research, development, and manufacturing activities at Ramo-Wooldridge. Work is in progress on a wide variety of projects, and positions are available for scientists and engineers in the following fields:

- Digital Computers and Control Systems
- Communications and Navigation Systems
- Guided Missile Research and Development
- Infrared Systems
- Electronic Countermeasures
- Electronic Instrumentation and Test Equipment
- Basic Electronic and Aeronautical Research

The Ramo-Wooldridge Corporation

LOS ANGELES 45, CALIFORNIA

. . . engineer shortage



R&D Funds will increase by almost 50%, engineering jobs will more than double by 1970.

year of chemistry, about ¼ had a year of physics and only one in 15 had taken advanced mathematics.

Foreign language study is compulsory in Soviet schools while only 14% of our students study a modern foreign language (of which 13% is French and Spanish). Only 16% of the engineers with a bachelor degree go on to a master's; only 5% to a doctorate.

The U.S. now faces a shortage of nearly 1,000 engineering teachers, with 9,500 new teachers required by 1966.

A report issued by the Rockefeller Brothers Fund warns: "By 1969, high schools will be deluged with 50 to 70% more students than they can now accommodate; by 1975 our colleges and universities will face at least a doubling and in some cases a tripling of present enrollments."

One possible leak between the high school desk and the engineering table was found in a national survey showing that almost half of the top 1/3 of graduating classes does not go on to college. (The Science Manpower Project of Columbia University, in a study of New Jersey high schools, found that about 1/3 of the top-quarter students named a career in science or engineering as their first choice.)

• **Pinning down the problem**—The House and Senate education committees this past session held hearings and collected data that together covered 3,671 pages, before writing an aid-to-education bill. Witnesses represented industry, education, government.

Although there was some disagreement on solutions, there was general agreement on the problems:

Industry's need for top-flight people in science and engineering would require more qualified teachers; The tapping and training of students with interest and intelligence; The stimulation of interest during the early high school years; The better utilization of currently employed engineers and scientists, plus additional training; More comprehensive math and science courses with higher standards required of students.

•**Sifting out solutions**—There were 26 education-aid bills introduced in Congress this year. Although some industry associations opposed it, much support was given the Administration's proposal for federal scholarships to top-flight students aiming for scientific and engineering careers. As originally written, the bill called for expenditures of over $800 million, covering a period of five years, including $97.5 for scholarships.

The National Defense Education Act, shorn of scholarships, authorized expenditures of $294.5 million in loans, out of a total $880 million to be spent over a four-year period. The National Association of Manufacturers, testifying against the bill, protested that student loan money has been going begging.

(A 1955 survey showed that of $14 million in various loan funds available to students, only $5.3 million was used. However, federal loans are given with more liberal terms than most—3% interest, with ten years to pay starting one year after graduation.)

NAM was one of many organizations which argued that while there is a shortage of *highly competent personnel,* "there is now no convincing evidence that an actual over-all shortage of scientists and engineers exists."

The Aircraft Industries Association also stressed that the need for top-flight people is more urgent than swelling the engineering ranks generally.

New laws may be some help

In addition to loans, the new education-aid law provides money for fellowships, guidance and counseling, new equipment, foreign language development, grants to states for supervisory services, research or modern education aids, a science information service and area vocational education programs.

Although this is the most comprehensive and ambitious Federal education project in the nation's history, it is considered by some educators to fall far short of what is required. Although general sentiment at HEW is "satisfaction" with this first step, one official said: "We needed a mountain and got a knoll."

The Office of Education plans to come to Congress again next year with another proposal for federal scholarships.

One other post-*Sputnik* government move in education was to triple the National Science Foundation's education budget to $62-million, of which about 20% goes for advanced scholar training and 60% for training of science teachers.

Several new programs have been started, including summer study courses for graduate teaching assistants and experiments with new approaches to science training.

•**Existing programs**—Although steps taken by the government fall far short of the drastic action predicted after *Sputnik,* industry and government's existing programs to ease the scientific manpower shortage have been picking up momentum.

• The Scientific Manpower Commission and the Engineering Manpower Commission of Engineers Joint Council, both formed in June 1950, have coordinated their activities to promote careers in their fields and to better utilize available manpower.

The commissions support efforts to recruit and train good high school teachers, encourage study of math in

. . . facing engineering shortage

high school and make manpower surveys.

- President's Committee on Scientists and Engineers. Organized in March 1956, the function of this group was to bring together influential private organizations of industry, labor, education, and professional societies to "foster the development of more highly qualified technological manpower." The committee, whose tenure ends in December, has been stimulating local action groups in communities to interest children in taking math and science and to improve those courses available. It spurs such scientific youth activities as junior science clubs, student science fairs and science day camps.

- Health, Education and Welfare. The Education Office assists in student counseling, conducts research studies, surveys various phases of science education, and makes available brochures and pamphlets such as bibliographies of new books in the scientific fields.

- **Industry participation**—Although no dramatic new programs have emerged lately, industry has been taking a much more active role in the last ten years to increase the quantity and quality of the high-grade help it needs.

Last year corporate donations to higher education were over $150 million. Other forms of industrial support include financial assistance to teachers, contributions of teaching aids and supplies, consulting services.

A NAM survey of its members showed that industry participation is on the upswing. Among 600 companies replying to a 1955 survey, 50% were cooperating with the science and mathematics departments of the local high schools; the following year it had jumped to 76%.

Some corporations pay the tuition of their young engineers and scientists who are working toward advance degrees and will allow them to devote a certain percentage of their on-job time to work on research of their own choosing.

An Aircraft Industries Association survey showed that for the 1956 school year, 23 aircraft and missile companies spent $480,000 for college scholarships and were planning to spend almost twice that much for 1957; $13.7 million was spent for formal classroom technical training over and above the "on-the-job-training" programs. AIA firms conduct over 1,500 courses for supervisors, engineers and technicians, costing the industries over $13 million in manhours alone, in addition to the cost of instructors and facilities. Most of these companies are planning expansion of their training facilities.

Future looks a little better

The U.S. Office of Education in its first survey of junior-year students by field of study, estimates that there will be one-third as many science and math degrees awarded next June as in June 1957.

The Engineering and Scientific Manpower Newsletter has stressed that " . . . the major problem is no longer one of student recruitment, but of educational quality all along the line and the provision of adequate facilities and faculty for higher education in engineering and science."

The National Science Foundation in a recent report concludes: "Some notable progress has been made and some major accomplishments undertaken . . . this is not a single emergency but a continuing—possibly a permanent—one . . . we have only made a beginning: the major job is still to be done."

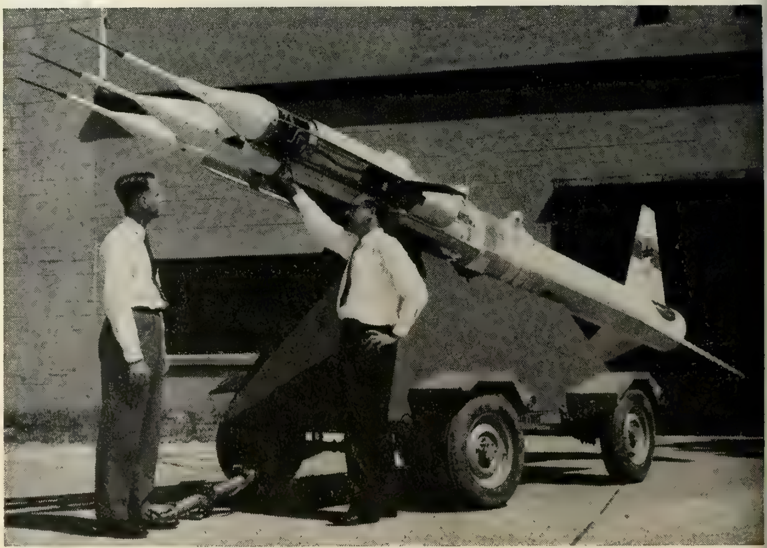
With consumer and defense needs rising while the nation faces a decrease in its young manpower supply, both industry and government are up against a challenge unique in the country's history. Automation will be only a partial answer. Until the electronics firms come up with a computer that can think creatively, the innovators will be at a premium and the Help-Wanted ads will continue to increase.

Although the number of PhD's in engineering remains low, the number of engineering enrollments has increased considerably. In September 1957, freshmen in engineering numbered 79,000 and total undergraduate enrollment for engineering degrees was 269,000, an increase of 7.2% over the previous year. This compares with an increase of 4.1% for all college enrollment.

The number of engineering bachelor degrees awarded increased 18.6% over the year before; masters degrees rose 10.8%, but the number of doctorates awarded declined 2.3%.

It is worth repeating the need: Although a year has passed since *Sputnik* I, we are still short 135,000 teachers—and the shortage is greatest in the fields of general science and mathematics. Teachers—as well as students—must be trained and brought into the field.

Missile Aids Escape Studies



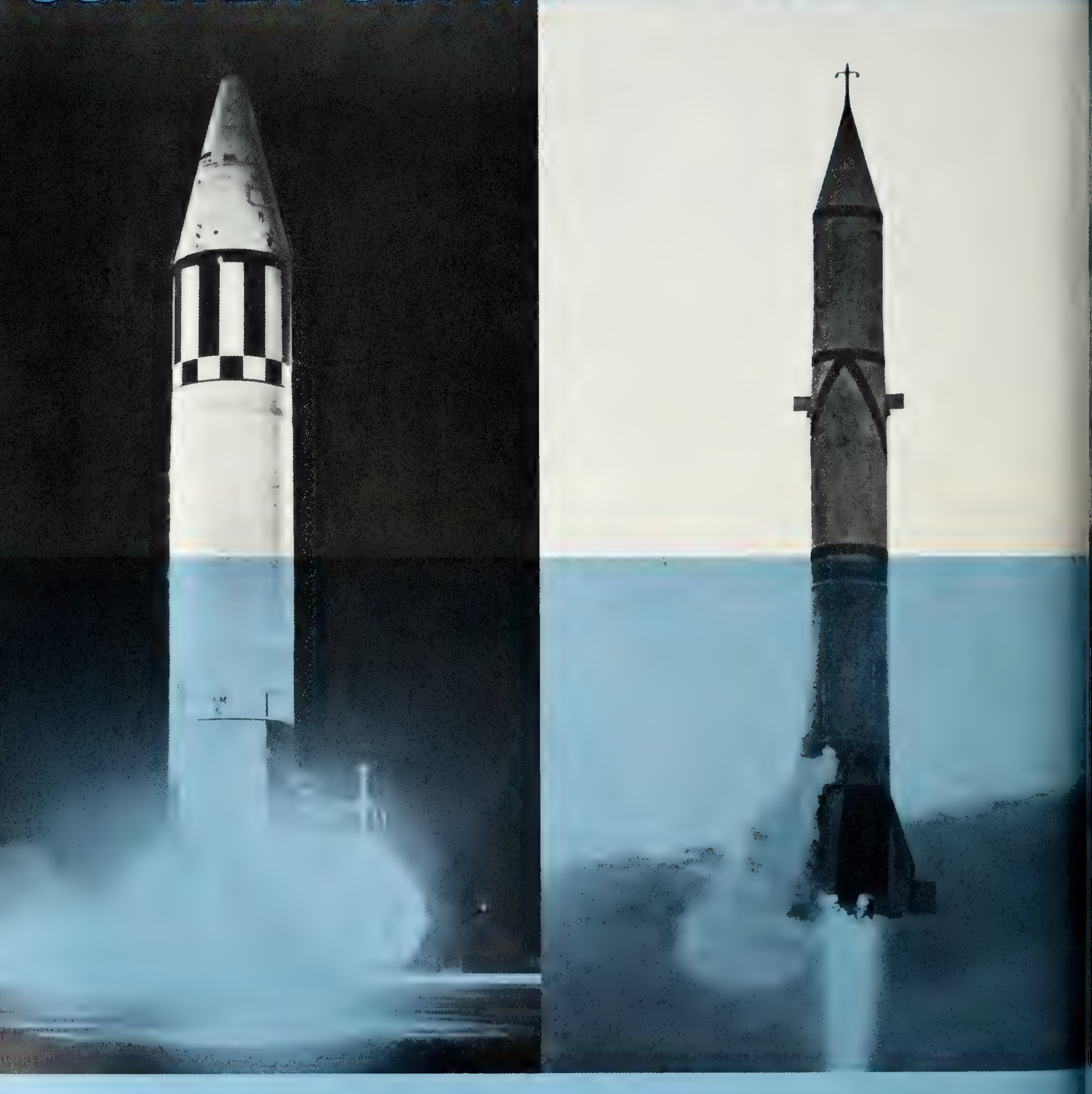
SUPERSONIC, THREE-PRONGED *"CREE"* will enable Air Force engineers to study first stage parachutes for manned aircraft escape capsules, missiles and drones. Developed by Cook Laboratories under a ARDC contract for Wright Air Development Center. *Cree* will eject three parachutes backwards at altitudes between 30,000 and 150,000 feet at speeds from 1,520 to 3,040 mph. The three test missiles are mounted on a ground-to-air missile booster unit. Telemetry data received includes speed, altitude, temperature and other atmosphere information.

FORD INSTRUMENT CO.
DIVISION OF SPERRY RAND CORPORATION
Long Island City 1, New York

MISSILE SYSTEM CAPABILITIES

FORD INSTRUMENT

JUPITER JUPITER C REDSTONE



missile experience...

includes systems, subsystems and components for many of our country's most advanced missiles

Ford Instrument Co. is currently engaged in research, development, and production on a wide variety of missile projects. Notable among these are the complete inertial guidance and control systems for the Army REDSTONE and JUPITER missiles; many such components for the satellite-launching JUPITER C; launching and control order computers for the Navy's TERRIER and TARTAR missiles; Air Force missile projects, including a no-gimbal inertial system; and a wide variety of ground support and production test equipment.

Today, Ford Instrument has the experience, facilities, and capabilities to enable it to undertake complex missile contracts of every type from component or subsystem to complete weapons system. And, as a Division of Sperry Rand Corporation, Ford Instrument's own weapons skills are backed up by the resources of a vast and diversified organization of complete technical and financial responsibility.

TERRIER Missiles on U.S.S. Boston. Ford Instrument-built computers solve launching and control order problems for this beam-riding missile. U. S. Navy Photo.

U. S. Army JUPITER (left) and REDSTONE Missiles. Cover shows satellite-launching JUPITER C. The guidance and control systems for these ABMA missiles were developed and produced by the scientific team at the U. S. Army Ballistic Missile Agency and Ford Instrument Co. U. S. Army Photos.

More than four decades of military systems engineering insure operational equipment . . . whether systems, subsystems or components

FORD INSTRUMENT missile abilities

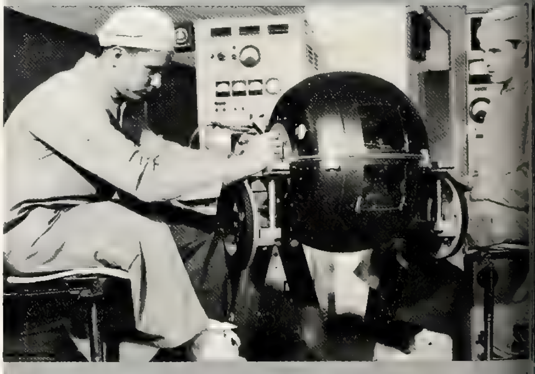
A unique combination of electronic, electrical and mechanical skills, devoted since 1915 almost exclusively to furtherance of military science, is the basic strength of Ford Instrument Co. Almost all of Ford Instrument's existence has been devoted to research, development and production of highly complex equipment, with laboratory precision and accuracy, yet able to withstand the rigors of military environments.

The proven reliability and extreme accuracy of the REDSTONE and JUPITER missiles, which employ guidance and control systems built by Ford Instrument—as well as the record of the JUPITER C—indicate clearly the company's capabilities in the area of guidance and control.

Another recent example of this type of work is Ford Instrument's design and manufacture of intricate warhead safety, fuzing and arming devices capable of withstanding the roughest environments. Few manufacturers are willing or able to undertake projects such as this and to carry them to completion. Ford Instrument has earned the reputation—which we are proud to acknowledge—of being able to do the "toughest jobs" in missile development and manufacture.

Contracting agencies or industries, with requisite security clearance and "need to know," are invited to examine further Ford Instrument abilities in difficult phases of missile research, development and production . . . whether for complete systems or specialized subsystems and components.

Warhead devices for missiles and other modern weapons. This precision warhead device (inset) made by Ford Instrument, successfully withstood atmospheric re-entry in the nose-cone of an Army JUPITER missile, shown here shortly after recovery from ocean.

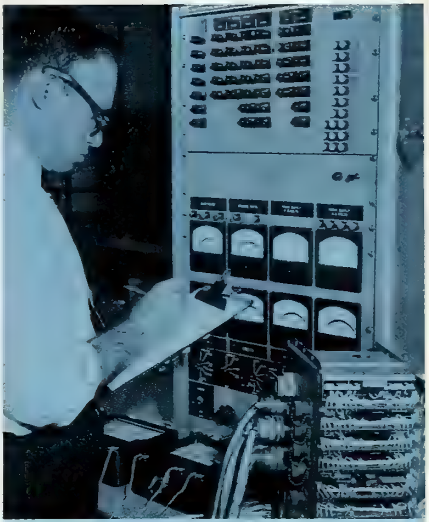


Stable platforms. Technicians here are performing test operations on a stable platform for the U. S. Army JUPITER Missile; these platforms are in quantity production at Ford Instrument.

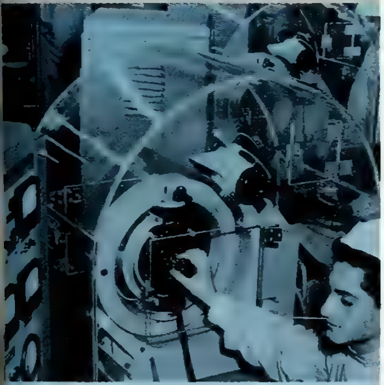
Launching and control order computers for TARTAR Missiles. Electronic and electromechanical portions of this all-transistorized modular computer are shown at left and right.

Actuators for jet vanes, air control-surfaces. This rotary actuator is driven by 1 hp d-c servo motor (shown in foreground with cable attached). Both motor and actuator are made by Ford Instrument.

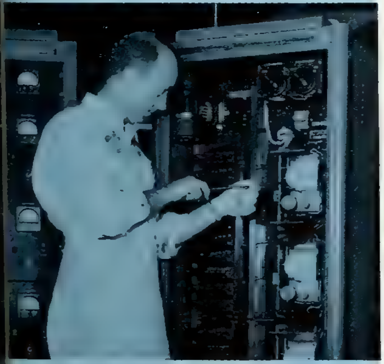
Missile-borne inverter. Vital missile component gets rigorous, precision performance checkout at console. All of the missile products delivered by Ford Instrument undergo full and complete testing procedures.



Missile-borne computers. Ford Instrument computer experience covers every phase of ballistic missile guidance and control. Typical is this control computer, shown during test, for U. S. Army JUPITER.



Specialized gyros and accelerometers. Ford Instrument pioneered in the quantity production of air-bearing gyroscopes and accelerometers. Air-bearing gyro here undergoes final test in special Ford-built test equipment.



Ground support equipment. Here pre-launch computer undergoes final adjustment. Modular techniques enabled this unit to be produced and delivered in less than 6 months.

current missile projects and equipment

SYSTEMS

- Inertial guidance and control systems and related ground support equipment
- No-gimbal pure integration inertial system
- Launching and control order computers
- Command guidance systems (for both missile and drone applications)
- Trajectory data system
- Missile velocity indicating system for test range applications
- Target locating system
- Radar target prediction and interpretation systems

SUBSYSTEMS (Missile-Borne)

- Safety, fuzing and arming devices
- Stable platforms
- Computers (control computers, guidance computers)
- Programming devices
- Inverter-regulators
- Transmitters

GROUND SUPPORT EQUIPMENT

Maintenance area, launch site and monitoring equipment, including:

- Impact prediction computer
- Aiming correction computer
- Pre-launch computers
- Test panels for computers and stable platforms
- Shipboard dynamic testers
- Monitor panels for guidance, stable platforms, alignment, and laying
- Test fixtures for a wide variety of components
- Combined sensor displays

PRODUCTION TEST EQUIPMENT

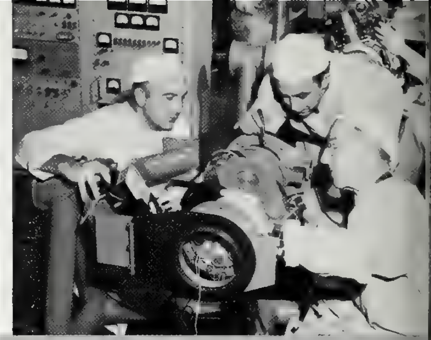
Systems and component test equipment including:

- Special environmental test units
- Quantity production test units
- Planetary test stands

SPECIALIZED COMPONENTS

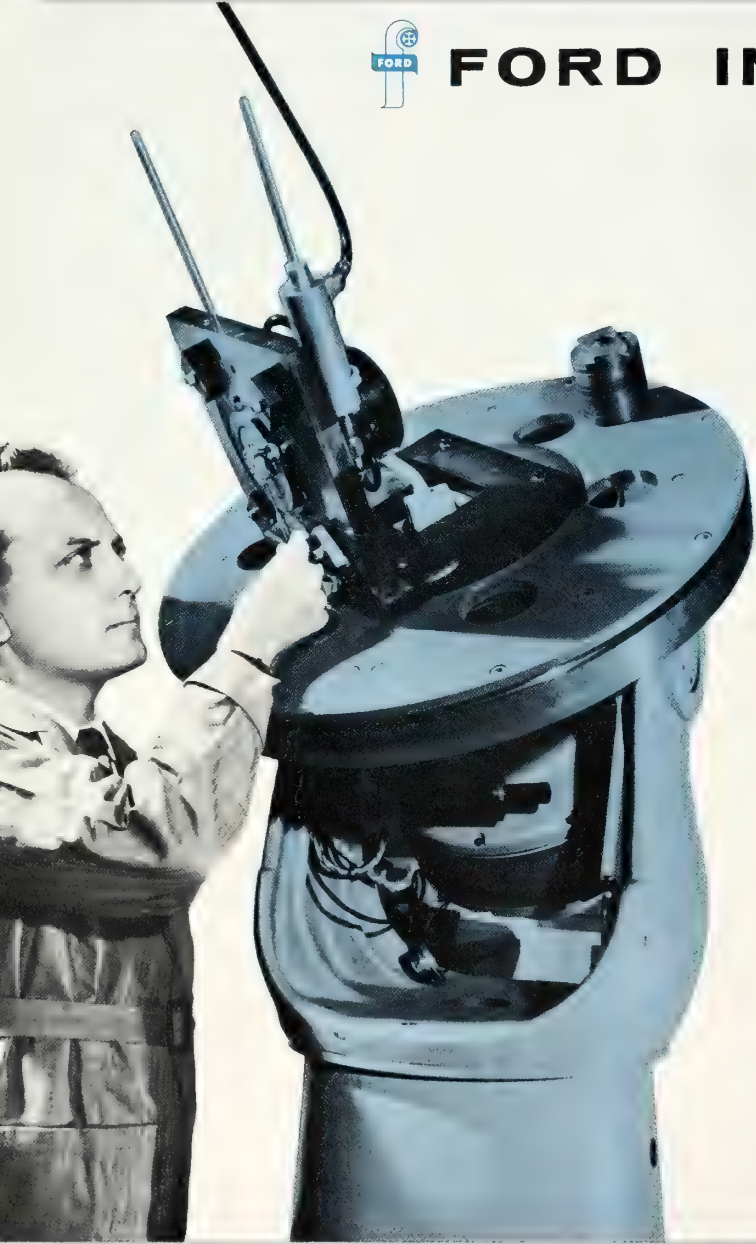
- Gyroscopes
- Accelerometers
- Actuators
- Mechanical integrators
- Transistorized amplifiers
- Relay packages
- Computer modules, both analog and digital, for a variety of missile problems
- Timing devices
- Shipping and storage containers

Drafting. One of Ford Instrument's many drafting departments, where topflight design draftsmen and technicians support research and development and also produce production drawings.



Technicians perform final checks on stable platforms for U. S. Army REDSTONE Missile in ultra-clean assembly area.

FORD INSTRUMENT

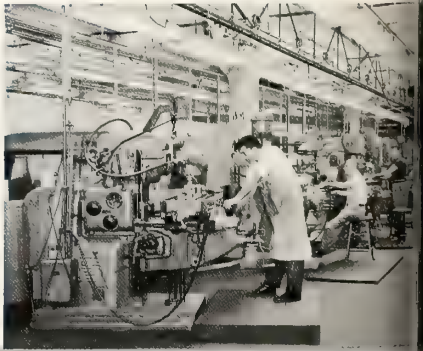


Extensive production and laboratory equipment implement engineering skill

Ford Instrument physical facilities make it one of the largest high-precision shops in the United States, fully equipped to handle every phase of development and production of complex missile systems. Initial studies, research, development, design, prototype construction and testing, final quantity production and quality control are expedited and facilitated by the most modern and highly developed equipment available for precision work.

Contracting agencies and industries possessing requisite security clearance are invited to make an on-the-spot inspection of Ford Instrument facilities.

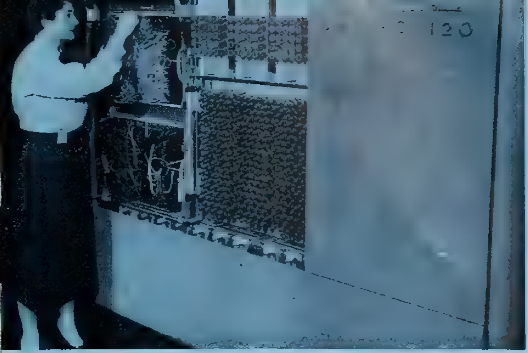
Equatorial test stand, built by Ford Instrument for its own laboratory facilities, is used for conducting basic drift error research. This type of unit can also be built to contractor order.



Many hundred standard machine tools, a few of which are shown here, are available at Ford Instrument for missile applications, as well as a wide variety of special machine tools.

Missile-borne tape programmers being assembled. Continuous development in this field is under way at Ford.

Air-bearing gyro accelerometer is tested here in Ford designed and built special fixture.



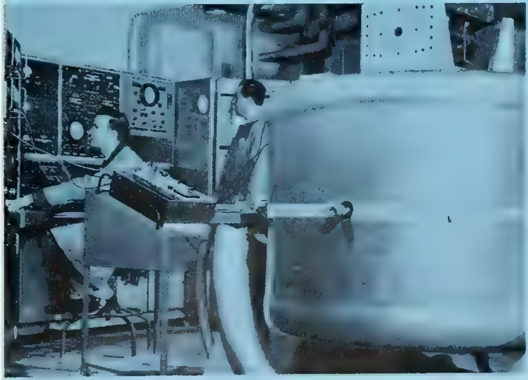
"Univac" computer is one of the general-purpose high-speed digital computers at Ford Instrument for engineering computations.

missile facilities

Typical of Ford Instrument Facilities:

- More than 30 laboratories for research, development and design in electronics, hydraulics, magnetics, mechanics and nucleonics, including fully equipped, ultra-clean gyro facilities.
- Advanced digital computing facilities with high-speed general purpose computers, including a Remington Rand "Univac." Ford Instrument scientists also have access to computing facilities of the Remington Rand Univac Division.
- An engineering shop, as large as many small manufacturing concerns, staffed by expert machinists and technicians, working under direct engineering supervision. The company also has fully staffed and equipped "short run" and prototype shops.
- Full production facilities—machine tools, shops, finishing and inspection facilities—for *large-scale* precision manufacture.
- A series of "clean rooms" for assembly of missile components. These rooms are dust-proof, temperature and humidity controlled areas with full environmental control procedures.
- Complete, elaborate environmental and other test facilities.

Giant centrifuge in special building at Ford Instrument can attain 60G's. Complete stable platforms—as well as components—are tested in this unit.



Vibration testing of missile component. Such tests duplicate inflight environments that components undergo when missiles are fired.

A special machine is used to mill irregular internal contours by an "electrical discharge" method, with extreme dimensional accuracy.

Technician grinds gyro part to a length within 20 millionths of an inch—typical of tolerances being met in missile work at Ford Instrument.

Engineering Shop. This shop makes breadboard models and other experimental products. It has much specialized equipment, e.g., toroidal coil winders, lapping equipment, in addition to standard machine tools.

Over four decades

of exacting weapons

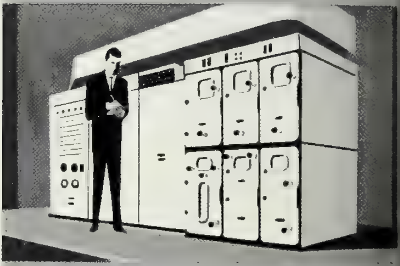
control systems

FORD INSTRUMENT related experience . . .

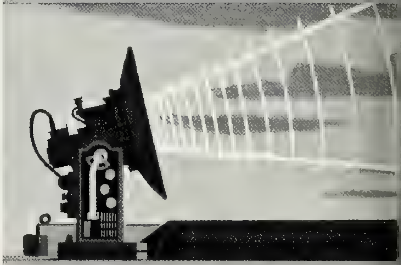
Ford Instrument Co. has been devoted to weapons control since its inception, originally pioneering computers and other automatic equipment for direction and control of naval gunfire. Today, Ford Instrument develops and produces equipment of wide variety for every branch of the armed forces and the U. S. Atomic Energy Commission, both directly and as a subcontractor through major manufacturers. The illustrations here give a small cross-section of the many hundreds of activities (other than missile) under way at Ford Instrument.

Ford Instrument welcomes inquiries from responsible contracting agencies in government or industry. Liaison engineers are available to discuss specialized requirements or to assist in generation of requirements for any service.

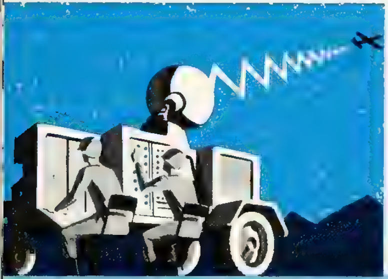
Navigation computers. Ford Instrument develops and produces automatic navigation systems for both U. S. Air Force and U. S. Army—for aircraft and surface vehicles.



Special-purpose computers. Ford Instrument computers are in wide use in all branches of the armed forces.

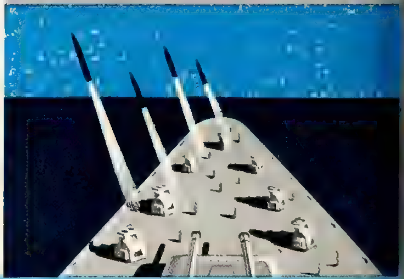


Telemetering and radar systems. A variety of projects at Ford Instrument range from "data-link" and other high frequency techniques—to radar intelligence interpretation and prediction projects.

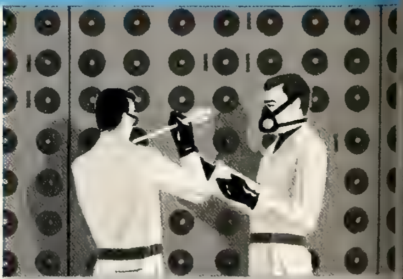


Drone control. Battlefield surveillance aircraft are remotely controlled by Ford Instrument system (radar, transmitting, computing and plotting equipment).

Mission control systems. Latest results of operational research and linear programming theory are implemented by Ford Instrument techniques.



Rocket and gunfire control. Ford Instrument has developed and produced a tremendous variety of fire control equipment for naval and land-based guns and rockets, as well as torpedos and missiles.



Nuclear development. Ford Instrument nuclear activities include reactor designs, instrumentation, control systems (including studies of digital techniques in reactor control) and highly classified weapons projects.

FORD INSTRUMENT CO.

DIVISION OF SPERRY RAND CORPORATION

31-10 Thomson Avenue, Long Island City 1, New York

Field Liaison Engineering Offices

DAYTON, OHIO
Ford Instrument Co.
29 West 4th St.
Dayton, Ohio

HUNTSVILLE, ALA.
Ford Instrument Co.
Redstone Arsenal
Huntsville, Ala.

LOS ANGELES, CALIF.
Ford Instrument Co.
260 South Beverly Dr.
Beverly Hills, Calif.

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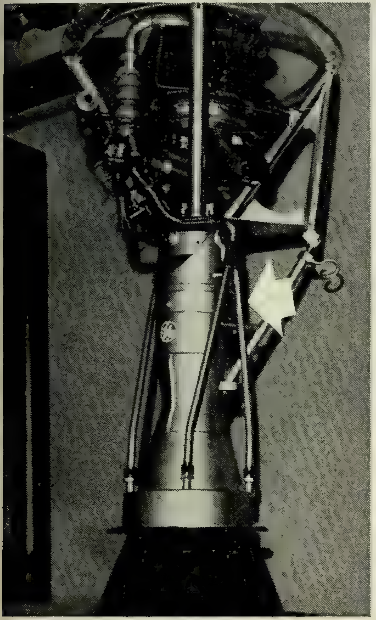

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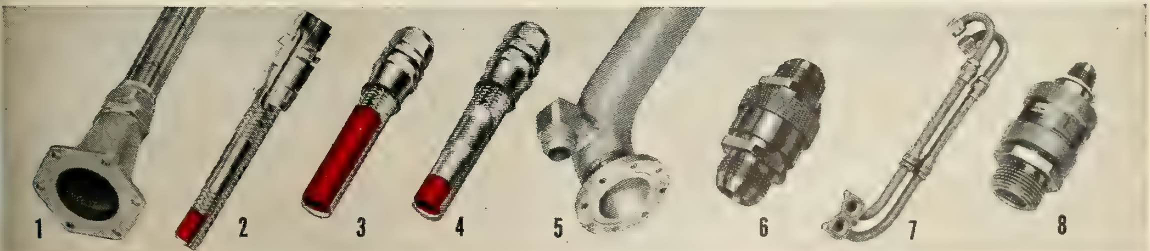

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Navy Not Discouraged Despite *Polaris* Failure

Despite the fact that the range safety officer had to destroy the *Polaris* test vehicle recently fired, the Navy is not discouraged.

"Reports that the missile corkscrewed all over the sky and was then destroyed are not accurate," a Navy spokesman said, "The missile behaved beautifully and was very stable."

"In fact," he continued, "this is the first time a solid propellant rocket of this size has been fired in such a perfect, stable, vertical flight. The trouble came from an extra motor, part of the test vehicle. This would not be part of an operational *Polaris*. It was supposed to angle the missile for flight over the Atlantic—it apparently went to sleep."

Rear Admiral W. F. Raborn, director of Special Projects, was reported "disappointed but not discouraged" by the partial success of the first full scale *Polaris*.

Meanwhile, the Navy is making improvements in the range safety precautions to preclude a recurrence of large pieces of the destructed missile falling in populated areas.

Nike-Zeus Testing Facilities Assigned

Central design agency for the test phase of the *Nike-Zeus* weapons system, as well as responsibility for the design of buildings, structures and utilities supporting the Army missile, is the Mobile, Ala. District of the Corps of Engineers. The facilities required are of varying complexities, and testing may be carried out under environmental conditions ranging from sub-arctic to tropical.

Soviets Invent Probe to Maintain *Sputnik* Stability

Soviet scientists have designed a probe for maintaining stable orientation of a satellite or rocket axis. In an article submitted to the Journal of the Soviet Academy of Sciences, G. A. Leykin explains the functioning of this probe:

"In the case of an oriented body moving at supersonic speed in a highly rarefied medium, a probe of comparatively simple design seems possible. In this case, it is possible to make use of the fact that the thermal velocities of the particles in the medium, although their speed is much less in relation to the body, are still high and cause erosion of the corpuscular umbra. The higher the ambient temperature, the greater the erosion.

"The simplest probe of this type can be made in the form of a tube."

propulsion engineering

by Alfred J. Zaehringer

Monopropellant work areas at USNOTS, China Lake, are concerned with the thermal decomposition of Two-nitropropane and the pyrolysis of acetylene by free radicals. Two-nitropropane decomposes in a first-order reaction to give propylene, nitric oxide, and water—indicating that this monopropellant is underoxidized. Acetylene compounds have long been eyed as monopropellant materials. Big catch has been a lack of understanding in kinetics of decomposition and stability.

Design of supersonic expansion nozzles for chemically reacting gases requires thermodynamic systems analysis. Ohio State University finds isentropic gas exponents for reaction in nozzles radically different than from gamma—the ratio of specific heats. Caltech has also been working with fast chemical reactions in supersonic nozzles.

Shock wave experiments are being used by the Soviets to study the dynamic compressibility of metals at pressures of 400,000 to four million atmospheres. Extrapolation leads to compressibility curves to 40 to 400 million atmospheres.

More superperoxide work has been reported at Lomonosov University at Moscow. According to the Russians, hydrogen superperoxide breaks down into ordinary peroxide and oxygen and liberates some 68 kcal/mole of oxygen.

Titanium for solid rockets? Rem-Cru and Titanium Metals Corp. have been working on high-strength (160,000-200,000 psi), thin, weldable sheet titanium. The sheet alloy contains 4% aluminum, 3% molybdenum, and 1% vanadium—the rest is Ti. Good high temperature corrosion resistance is viewed. Both steel and aluminum alloys are now widely used for solid motors.

Boron polymers for solid propellants may be a distinct possibility. Pyrolysis of diborane can yield various fractions of boron hydrides, says American Potash & Chemical. Very little, however, is known about such polymers above $B_{10}H_{14}$. Such pyrolytic polymerization takes place at temperatures of 194-250°F and pressures of ½-1 atm.

Study of mixed, solid oxidants is being conducted at Picatinny Arsenal. Thermal studies of perchlorates and nitrates—at temperatures up to 325°C—could lead to improved physicals in one oxidant composite systems. Mixed oxidant solids aren't too popular in the U.S. On the other hand, the USSR is pushing hard on two and three oxidant solid systems in an effort to improve operations at both ends of the spectrum—phase changes at low temperatures and stability and decomposition at the near-ignition hot end.

Critical diameter for ammonium nitrate propellants has been confirmed by du Pont and University of Utah. Mixtures of AN and hydrocarbons can be exploded. This indicates the caution that the solid people will have to face in the scale-up of large AN booster rockets.

Water in missile fuels is a problem with the RP-1 petroleum based stocks. The problem is even greater than that experienced with ordinary jet fuels. Reasons: heavy distillate stocks are hydrophilic, have high densities that keep water from seperating out, and often water drops are kept emulsified by electrical charges. Result: at low temperature, the water freezes, changes viscosity of fuel, and sticking occurs in lines and orifices. One way out is to filter all fuel periodically. Present line of US ICBM's and IRBM's use this fuel.

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Take the case of the U.S. Air Force's (IRBM)—THOR missile project. FMC's design engineers developed the transporter-erector and launcher portion of the ground support equipment with Douglas Aircraft Company, Inc., prime contractor. The first units were engineered, manufactured and delivered in just eight months—2 months ahead of schedule.

FMC is not looking for "crash programs," but when the need arises, we go all out to meet deliveries. The delivery deadline for the THOR transporter-erector, launching base, and power-pack trailer was met because FMC handled the complete project—design, engineering, and production—with experienced people, at a single facility devoted exclusively to military equipment production. *Consult with FMC at the initial stage of project planning.* Contact us today for full information.

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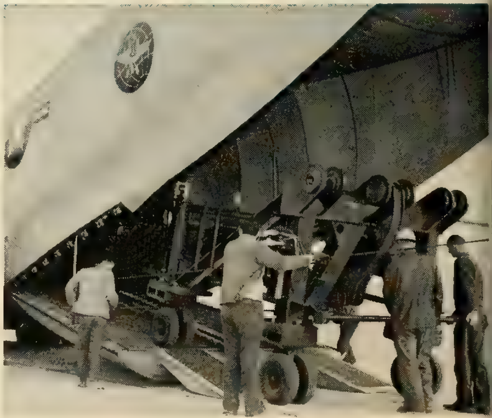

Missile equipment takes to the air in Air Force's giant C-13 transport which flew FMC-built Thor ground support equipmen from West Coast to test site at Cape Canaveral, Florida. First loa (upper) takes 65' launcher-erector section. Launching base an power-pack trailer (above) were flown in a second shipment.

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missile business

by Donald E. Perry

Even though Air Force is buying missile spares on a relatively small scale compared to airplane spare procurement, it's still high-dollar purchasing.

Lt. Gen. C. S. Irvine, deputy chief of staff, materiel, points out in Air Force's 1959 budget estimate, missile spares represent 8.8% of the actual hardware portion cost.

Method of handling spares is contrary to past philosophy on airplanes. Air Force has no intention, according to Irvine, of placing missile spares in depots. Rather, the plan is not to have spare parts any place except where the operating missile is located. If a component goes bad, it will be returned to the manufacturer's plant. The intention of stocking package components from engines on down to smaller items will be done on "a strictly commercial-type operation," Irvine said, with the factory being the warehouse for spares.

It's interesting that Air Force, which is carrying $9.8 billion in spares (to be used in a four-year period), spends roughly 20% of spares acquired in a year, with 80% being the repairable type items which are returned to various systems.

Irvine said if missile programs stabilize, it may be necessary as in the case of *Thor* running out of production, for Air Force to buy life-of-type spares to finish out the remaining *Thors*.

Department of Defense will spend $2 billion more in FY 1959 than in 1958, but the cash outlay for missiles and aircraft will be about $30 million less. Total expenditure planned is $40.9 billion, compared with $39 billion. Expenditures for aircraft and missiles will be $10.9, compared with $11.2.

A Senate Small Business subcommittee estimates that smaller firms will receive less than two percent of $5 billion to be spent on prime missile contracts this year. After hearings earlier this year (m/r, June, 1958, p. 80), action was demanded from every service to improve procurement. Lack of adequate item specifications, and Pentagon practices of buying one item from one source, was cited by the subcommittee.

With industry in a decided business upturn from recession earlier this year, there is a growing tendency, even in the missile market, to go slow in rehiring or adding new workers. Many business leaders feel a cautious approach is necessary because there is no unanimity that the upturn is solid. This mainly applies to production workers, but there's still a demand—and a great one—for experienced technical help, with personnel requisitions stacking up high.

Expansions—Standard Steel Corporation of Los Angeles has opened a new $500,000 facility for alloy engineering and fabrication, principally for "vacuum-bottle-type" low temperature rocket-fuel tanks . . . **Martin-Orlando** is adding a $442,000 personnel office to its plant, and an additional 35,000 square feet of floor space. Expansion was apparently made necessary with receipt of prime responsibility for *Pershing* system . . . **Control Data Corporation,** Minneapolis electronics firm, has moved into new general offices and opened a new computer research and development facility . . . **Ampex Corporation,** San Francisco manufacturer of video and audio tape records, has leased an additional 63,000 square feet of floor space for engineering expansion . . . **Johns-Manville Corp.** has proposed a merger with **L.O.F. Glass Fibers Co.** on the basis of one share of its common stock for two and one-half shares of the other's stock . . . Construction has started on a 76,000-square-foot addition to **Sylvania Electric Products** electronic defense laboratory, Mountain View, Calif. . . . Fast tax writeoffs have been approved for major companies with heavy missile commitments. **The Martin Co.'s Denver Division** got four certificates covering research, development and testing of missiles, for $252,298, $577,000, $74,992 and $560,000.

contract awards

LAST MINUTE AWARDS

Republic Aviation Corp. has received $464,000 for intermediate range and intercontinental ballistic missile components.

NAVY

New York University, New York, N.Y., received $40,000 for research on the quantum theory of fields using group-theoretical and functional-theoretical methods.

Ferranti Electric, Inc., Hempstead, N.Y., received $50,000 for investigation of the feasibility of extending present delay line techniques into areas compatible with underwater acoustics.

American Institute of Biological Sciences, Washington, D.C., received $30,000 for symposium on ecological problems related to confinement in the true submersible or sealed space cabin.

Hydel, Inc., Cambridge, Mass., received $30,000 for research leading to a design and construction of a full scale high density writing and reading photographic storage device.

Aerojet-General Corp., Azusa, Calif., received $134,360 for Aerobee-Hi rockets.

ARMY

By Purchasing and Contracting Div., White Sands Missile Range, N. Mex.:

Delta Steel Bldgs. Co., Dallas, Texas, received $32,328 for Igor Tower, Malpais Spring, White Sands Missile Range, N. Mex.

Douglas-Aircraft Co., Inc., Santa Monica, Calif., received $128,326 for Blue Streak and emergency repair parts for the *Nike* system; $50,625 for repair parts for the *Nike* system.

AIR FORCE

by Headquarters, Air Force Office of Scientific Research, Air Research and Development command:

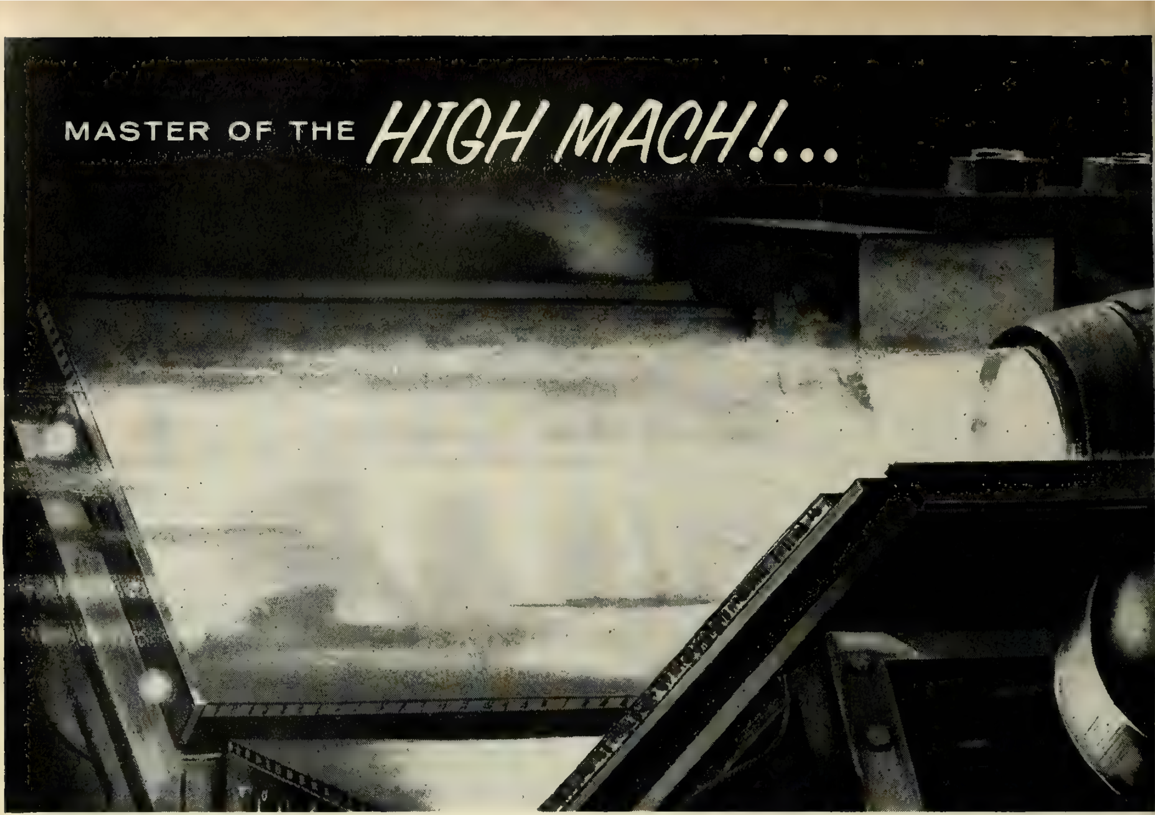
Bell Aircraft Corp., Buffalo 5, N.Y., received $115,734 for continuation of "Program of Exploratory Research Concerning Observation of Burning Propellants in Rocket Engines."

Ohio State University Research Foundation, Columbus 10, Ohio, received $48,775 for research on "Value Acts and Situational Variables in Organizational Behavior."

Cornell University, Ithaca, N.Y., received $54,816 for continuation of research on "Theoretical and Experimental Investigations in High-Speed Aerodynamics."

University of Maryland, College Park, Md., received $32,000 for continuation of research on the theory of scattering.

Boston University, Boston 15, Mass., received $28,343 for research on chemical properties of "active nitrogen."



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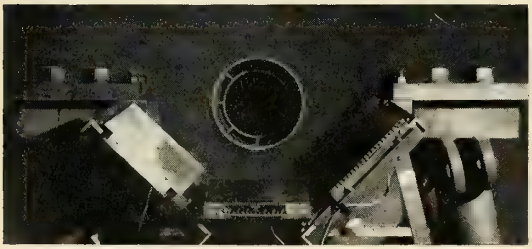
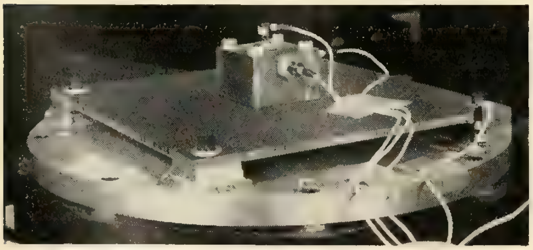
AERONCA STAINLESS STEEL HONEYCOMB STRUCTURES



SONIC FATIGUE TESTS prove ability of Aeronca brazed honeycomb to withstand high acoustic energy levels.



HIGH FREQUENCY VIBRATION TESTS prove resistance of Aeronca structures to sustained G loads.

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New concepts in air weapon systems . . . both manned and missile . . . generate critical stress factors that exceed the limitations of conventional structures. New concepts in structures, therefore, are a fundamental need to advance air weapon technology.

Stainless steel brazed honeycomb structures produced by Aeronca are meeting many of the "impossible" specifications inherent in High Mach performance. This is no mere coincidence. Aeronca has pioneered in developing high-temperature honeycomb fabrications. As a result, we are one of very few companies capable of producing these specialized structures in quantity.

Write today for details. Formal letterhead inquiries will receive immediate attention.

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Global Group Seeks To Perpetuate IGY Work

WASHINGTON—One of the more important actions at the recent meeting of the Bureau of the International Council of Scientific Unions (ICSU) here was the formation of a global scientific committee to devise means to perpetuate the cooperation in space research that has marked the International Geophysical Year.

The new committee, approved unanimously with West Germany absenting, will be known as the Committee on Space Research. It will consist of about 15 members with the United States and the USSR both members of the five-man executive committee.

As its main objective, it is charged with the duty of submitting to the next meeting (about a year from now) of the executive board of ICSU, a plan for coordinating space research and the exchange of information resulting from the research. An additional phase of work for the committee will be keeping an eye on programs for space control in the United Nations and elsewhere.

Members for the committee were chosen from nations launching satellites and those with other major rocket programs. Other members were picked from the nine international scientific unions taking part in space research and from three additional nations engaged in tracking or other aspects of space science. The three nations will be chosen on a rotating basis, indicating that the committee will last beyond the end-of-1959 date authorized.

In his opening remarks to the delegation, Lloyd V. Berkner of the United States, president of the Internation Council, said that "with the closing of the IGY, the basic question is raised whether international collaboration in space scientific research should be continued under the auspices of ICSU. Consequently, ICSU asked its members for their views on creating an ICSU committee on Space Research (COSPAR) to continue collaboration in planning of space research under ICSU following the IGY.

"The response has been favorable and the Executive board has authorized organization of COSPAR for the next year to aid in development of plans for space research on an international base of free scientific activity, and to report to the Executive board at its next meeting those measures needed for further international collaboration in space research."

All of this probably means that the equivalent of an IGY may exist for many years to come. The ICSU, under whose stimulus and sponsorship the IGY has been organized and conducted, works to accomplish its mission by coordinating the activities of its 13 member International Unions. It is non-governmental and seeks to operate outside the realm of individual politics.

One of COSPARS first moves will be to absorb CETEX, the Committee on Contamination by Extra-Terrestial Exploration, which specifies the conditions of landing on other planets that would keep contamination to acceptable levels. Another aim will be inducing nations capable of launching satellites, moon probes, or other spacecraft to reserve part of their payload for scientific experiments by other nations.

AIL Forms Department For Space Technology

NEW YORK—Airborne Instruments Laboratory—electronics division of Cutler-Hammer, Inc.—has formed a new department to handle activities in the space technology field.

AIL for some time has been working on a series of ARDC contracts calling for highly advanced electronic systems for the nation's space program. These contracts have now been grouped into a single activity under the name Project STAR (Space Technology and Advanced Research), and all work will be concentrated within department.

About 225 persons—more than 100 of them engineers, scientists and mathematicians—are working for the project, which will be headed by Winfield E. Fromm. Emphasis is on analysis of the operational problem, system design of both space and ground equipment, and reliability.

In outlining the program, Fromm said:

"Overcoming the known problems is a staggering assignment, but perhaps even more staggering are the problems posed by the unknown and the unique nature of space itself. We will have to develop sensitive equipment which will have to perform under the intense bombardment of cosmic rays and other forms of radiation, together with equipment that will contain bearing lubricants which will not evaporate in the vacuum of space.

We plan on developing instruments with parts that will not overheat when there is no atmosphere to help dissipate the heat generated in the equipment.

"Then there is the intriguing problem of equipment which will combat weightlessness. As the circling speed of the space vehicle balances out the pull of gravity, tiny bits of dust and other foreign particles, which ordinarily would remain harmlessly at the bottom or on surfaces of the equipment, will begin floating weightlessly about—each piece a drifting derelict, a potential trouble-maker in every precision mechanical and electronic assembly exposed to it."

Defense Electronics Buying Sets Record

Defense electronics procurement during fiscal year 1958 ended last June 30, totaled $4.050 billion and is considered by the Electronic Industries Association to be the largest amount spent by the military for electronics in a single year.

Based on its formula to extract that portion of military spending for electronics from all major defense procurement categories, EIA reports total expenditures in the fourth quarter (April, May, June) to be $1.187 billion, a considerable increase over third quarter buying of $969.5 million, and over the $967.5 million spent by the Armed Services for military electronics gear in the second quarter of FY 1958.

Cumulative spending for electronics by the Defense Department during the 12-month period, added to such expenditures since fiscal year 1951, shows military electronics procurement near the $23 billion level—or $22.807 billion—based on the EIA figures.

Intended primarily to be used to depict trends, and subject to later revision, the EIA computation shows the following electronic figures (in millions of dollars for fiscal year 1958).

Budget Category	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	TOTAL
Aircraft	$340	$346.0	$359.0	$401	$1,446.0
Ships-Harbor Craft	23	25.0	24.0	27	99.0
Combat Vehicles	1	—.2	—.1	1	1.7
Support Vehicles	1	.7	.6	2	4.3
Missiles	273	299.0	319.0	377	1,268.0
Elec. & Comm.	204	214.0	183.0	274	875.0
Research & Dev.	73	74.0	75.0	96	318.0
Miscellaneous	11	9.0	9.0	9	38.0
TOTAL (FY 1958)	$926	$967.5	$969.5	$1,187	$4,050.0
TOTAL (FY 1957)	$637	$876.0	$938.0	$1,055	$3,560.0

OCT. 20-30...PROJECT WILLIAM TELL...

RYAN FIREBEES TEST AMERICA'S AIR DEFENSE IN FIRST WEAPONS MEET TO USE JET TARGETS

Ryan Firebees are the exclusive flying "bull's-eyes" for the Air Force Project "William Tell"—first weapons meet to use free-flying jet targets. 100 Firebee jet drones will test the pilots, planes, and missiles of America's air defense system under the most realistic "combat" conditions ever achieved.

Firebees will not only draw the fire of the nation's crack Air Force pilots: they will score the results in mid-air with a new electronics system. A running record of hits, misses, and near-misses will be instantly transmitted from Firebees to scorekeepers on the ground. Other Firebees will photograph missiles boring in—or streaking away if they don't score a "hit."

Pitted against the Firebees in this world-wide weapons meet will be the top Air Defense Command squadrons, flying Convair F-102, Northrop F-89J and North American F-86L interceptors. They will fire deadly Falcon guided missiles, and Genie and "Mighty Mouse" rockets.

Only the Firebee—the most advanced target drone—has the high performance, reliability, and extended duration needed for realistic weapons evaluation. In service with the Air Force, Navy, and Army, Firebees are flying in greater numbers and for more hours than any other jet target drone.

The Firebee is another outstanding example of Ryan skill in blending aerodynamics, propulsion, and electronics knowledge to produce a superior product.

RYAN BUILDS BETTER

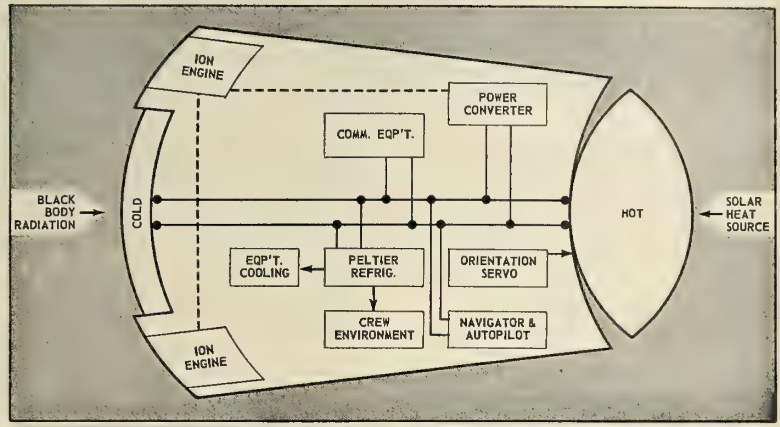
AIRCRAFT • POWER PLANTS • ELECTRONICS

Ryan Aeronautical Company, San Diego, Calif.

Sun to Cool Spaceship Electronic Components

Solar Discs, developed by Northrop, could also power satellites by using well-known refrigeration principle.

by Raymond M. Nolan



NORTRONIC'S PROPOSED space ship would contain the various elements shown here.

The sun is to be used for cooling infrared sensors and other electronic components in a method now under development by the Nortronics division of Northrop Aircraft.

The cooling would be a byproduct of a solar-powered space vehicle, using principles of physics to develop electricity. Basic elements of the system will be a solar disc to provide power and a Peltier refrigerator to furnish the cooling.

Nortronics' space ship would use the sun to heat a disc, which would in turn be connected electrically to another element to radiate heat into space. The difference in temperatures would produce electricity, which would then power ion engines and operate other equipment in the vehicle. One piece of equipment would be a Peltier refrigerator which can cool without using refrigerants, and has no moving parts.

The principle that is used both to power the engines and to provide the cooling is known as the Peltier effect—one of several phenomena that occur when a current is passed across the junction of two dissimilar metals, or when different temperatures exist in the two metals.

• **How it cools**—The theory on which this effect is based uses the analogy that electrons are a more or less ideal gas. One result is that an electron gas may be subjected to a refrigeration cycle, where in heat is extracted from a reservoir at low temperature by a refrigerant which rejects it at a higher temperature.

Peltier discovered the phenomenon on which this analogy is based in 1834, when he observed that a voltage applied to a circuit consisting of two dissimilar materials resulted in the absorption of heat at one junction of the circuit and the emission of heat at the other junction. This—the Peltier effect—produces the cooling in the Nortronics device. A converse application where two materials are kept at radically different temperatures results in the generation of electricity.

M. B. Grier, Nortronics Project Engineer, in a paper entitled, "Thermoelectricity, New Horizons for Missiles," describes the development of tiny refrigeration devices which use the Peltier effect and speculates on the uses of the effect for powering satellites and other vehicles.

The tiny electronic refrigerator, capable of inducing a 50° (or more) temperature drop in sensitive electronic components, was developed by engineers in Nortronic's Advanced Planning Department. Two units have been delivered to the Navy for evaluation. The present refrigerators use conventional power sources, but future units for satellites or space ships will use power generated by a solar disc, also under laboratory evaluation at Nortronics.

• **Where to use it**—Grier points to the present method of cooling infrared sensors by liquid nitrogen as a good example of a spot where a Peltier refrigerator could be substituted.

The liquid nitrogen method is effective, but requires considerable space and has a definitely limited period of operation. For a satellite application requiring long-time "on" periods for the infrared sensor, he believes that Peltier cooling is the answer.

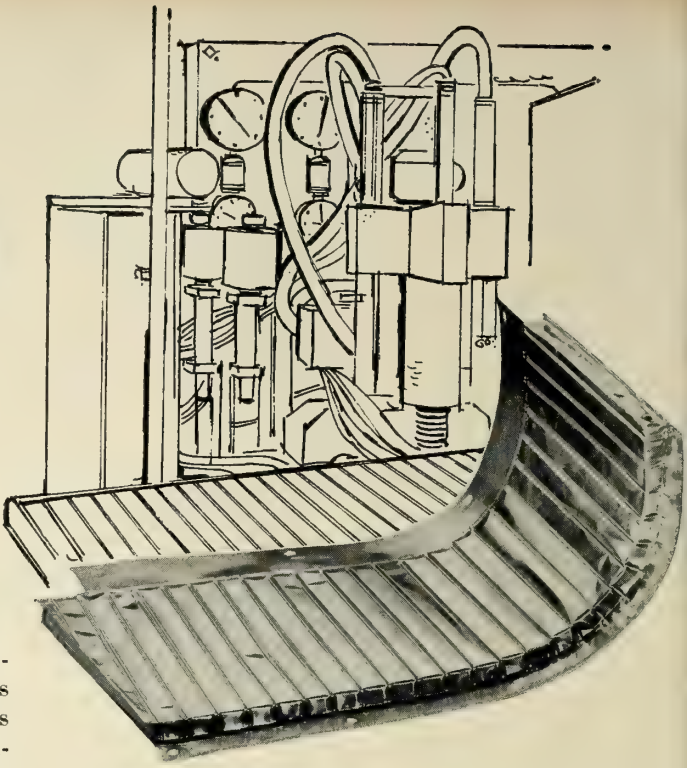
The refrigerator-photosensor shown in the accompanying illustration is mounted in an aluminized evacuated envelope. The refrigerator-cell assembly is mounted on thermally massive copper support discs, which in turn feed through an insulating support disc. The supports are equipped with cooling fins and lugs for fastening leads. The photodetector is a lead sulfide cell which is fastened to the cold junction.

The required driving voltage is about 250 millivolts at 10 amps, or 2.5 watts. Power for intermittent operation is a zinc-silver oxide secondary cell which furnishes approximately one volt with very high current for relatively long durations. A silicon rectifier could be used for continuous operation.

• **Solar receiver**—The solar disc (see block diagram) visualized by Nortronics engineers would take the form of an eyeball-shaped solar energy collector, servoed to continuously face the sun without moving the vehicle. The black-body radiator on the other end of the craft would be recessed slightly so that its acceptance angle for rays of the sun would be minimized.

The temperature differential which would exist would produce electrical energy. With this power, the vehicles would be propelled and would have self-contained power and cooling for communications equipment. A power converter would provide the voltages

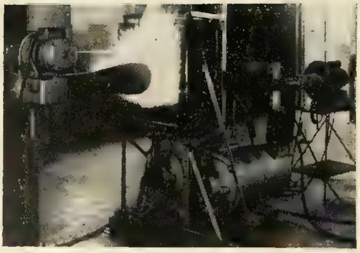
Look to **L·O·F GLASS FIBERS** for the first truly complete custom-made insulation service



Leaders in the aircraft and rocket industries look to L·O·F Glass Fibers Company for the new developments in both thermal and acoustical insulating components, because this is the *only company in the glass fiber field* that performs all of the following:

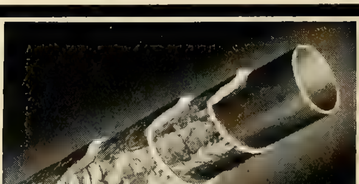
> **starts with the sand . . . turns it into glass . . . draws it into fibers . . . forms them to specification . . . covers them with metal or plastic in custom fabrication.**

L·O·F Glass Fibers Company fabricates insulation for thermal applications (up to 3000°F.) and a wide range of acoustical applications, including: de-icer duct insulation, tail-pipe and afterburner insulation, turbine case insulation, engine parts insulation, hot-air duct insulation, cabin-heater duct insulation, cabin insulation, structural insulation and bleed-air duct insulation.



Insulation blanket made with ½ inch of Micro-Quartz felt withstands the searing heat of a 2000°F. flame.

Wrap-around blanket, encased in stainless steel, shields hot-air duct at 600°F. Insulation will not pack, settle or crumble.



New Micro-Foil tape, made from Micro-Quartz felt faced with aluminum, protects parts too small for molded or shaped insulation.

For:
- **Design or engineering aid**
- **Bulk insulation price lists**
- **Fabricated-parts quotations**
- **Technical information & samples**

L·O·F GLASS FIBERS

WRITE: L·O·F GLASS FIBERS COMPANY, PACIFIC COAST DIVISION
BURBANK, CALIFORNIA

. . . sun to cool components

necessary for the ion engines.

One further use of the Peltier refrigerator would be in maintaining the proper crew environment if the ship should be manned. Cooling for comfort and dehumidification for moisture recuperation would be possible through the use of a portion of the electrical power generated by the solar disc.

Of course, there are serious limitations to the use of this effect for propulsion and high-power equipment.

One of the greatest would be the size of the "hot" part of the disc. Another would be the stability required so that the disc would face the sun at all times. However, Nortronics engineers feel that these are no greater than problems which face all designers of space vehicles.

• **Potential uses**—According to Grier, the Peltier refrigerator principle has a vast potential for both military and commercial applications.

It is possible, he says, to cascade Peltier units to obtain unusually high levels of refrigeration. This might provide the heat-sink method now being sought by almost all electronics designers where the extensive use of semiconductors and their serious drawback of thermal runaway poses a tough problem.

Transistor engineers feel that they can design almost any type and size of electronic device if something can be done about the heat dissipation problem, but most of the solutions now in use or under investigation use some type or another of metal heat sink. This just about nullifies the size and weight saving gained by the use of semiconductors.

One application which could benefit from Peltier cooling would be the high-power, low-weight static inverter presently on many drawing boards.

Static inverters do exist, but do not produce the power levels required by many of the larger guidance systems. It has been estimated that the inertial guidance and control system on an IRBM or ICBM requires about 2000 VA of well-regulated, 400-cycle, 110-volt power.

Most of these systems use standard motor-generator sets with large regulators to achieve the power they require, but problems such as size, weight and the interaction between gyros and the rotating inverter make a transistorized power supply look attractive.

The main drawback to this method, however, is heat dissipation. With Peltier units for cooling, energized from their own power source, the large static inverter could become a possibility. This, coupled with other electronic cooling, would result in significant weight reductions in guidance systems, either for the big missiles or for space vehicles.

PELTIER refrigerator used to cool infrared sensor.

• **Direct electricity?** Among the more promising of the applications for the thermoelectric generation of power is the possibility of converting directly from nuclear energy to electricity without intervening moving parts. To accomplish this, a heat producing isotope such as PO 210 may be chosen as the energy source which easily emits radiation such as beta or alpha particles.

In connection with this, it is interesting to note the testimony before Congress of Col. Jack Armstrong, Deputy Chief, Aircraft Reactors Branch, Division of Reactor Development, Atomic Energy Commission.

Col. Armstrong said, "SNAP III (Secondary Nuclear Auxiliary Power) is a very new one to us. We ran across some work that is being supported by the Navy and we took advantage of this. Its work is with Westinghouse, I think, as a result of some Russian work.

"We are trying to utilize this to provide an extremely light, an extremely small source of power for something like the *Vanguard*, or something of that type, and this is only three watts of electrical energy for six months and will probably weigh not over 10 pounds . . . This is a mixed valence oxide. These little pellets you see here, I have actually seen demonstrated. You put fins on one end to cool them, you apply heat to the other end and electrical energy flows out . . . That little gadget is about 8% efficient, but they feel that efficiencies can be increased up to 15% and, perhaps, to 25%.

"If this pans out, we would then use polonium as a radio isotope for a heat source on one side, and then we would have a very close approximation of conversion of atomic energy into electrical energy."

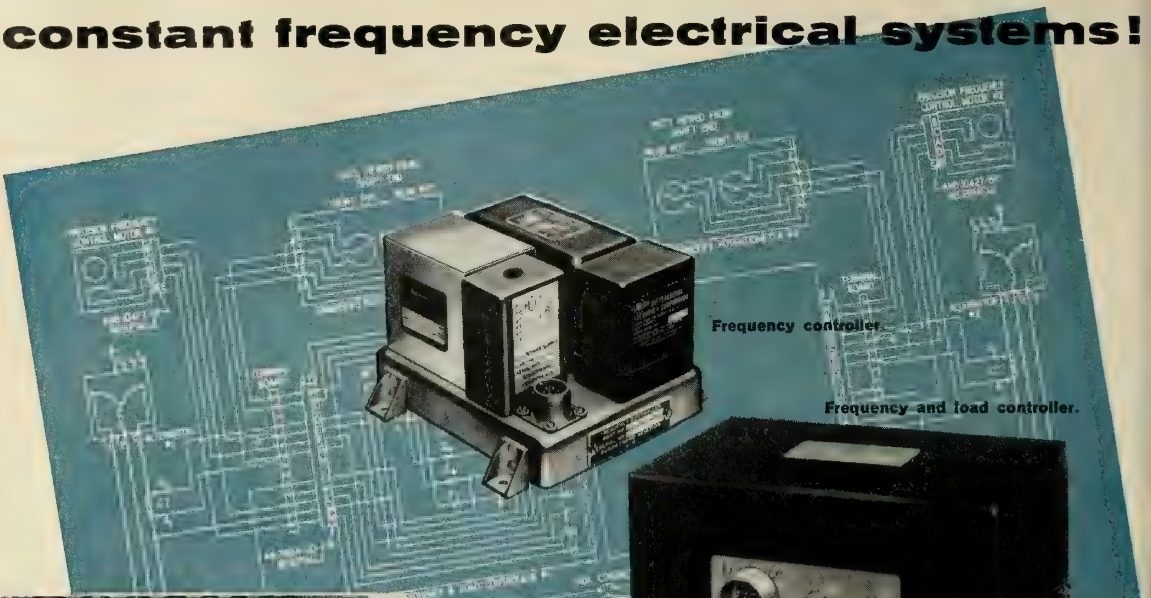
• **Smaller converters?** But even before some of the more advanced uses of thermo-electricity are in use, devices might be developed which take advantage of the Peltier effect. Currently the most direct method of conversion of electric energy from solar power is by means of the silicon solar cell. Such cells are currently yielding efficiencies of the order of from 8 to 14% and are light and highly reliable. Efficiency is reduced with increasing temperature, tests have shown.

However, Grier says that work at the Nortronics Laboratories indicates that it is possible to construct a thermoelectric solar converter which is comparable in efficiency with the silicon solar cell under free space conditions. The thermoelectric converters could be used with concentrators to increase their efficiency, resulting in increased utilization of power from the sun.

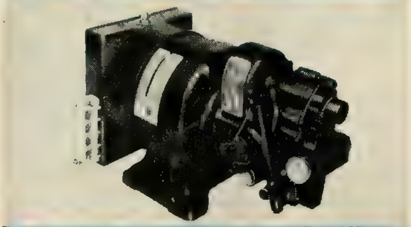
Many companies in the missile business are investigating the Peltier effect for application to their advanced projects, but most report that the main impediment to design so far has been the materials used to form the junction. Early experiments used iron and constantin, but power requirements were high and cooling capacity was low. Nortronics is reluctant to name the materials used in their units but a good guess would be Bismuth-Tellurium and alloys of Zinc-Antimony and Bismuth-Antimony.

Two companies investigating Peltier refrigeration are General Electric and Westinghouse, indicating that these units might some day appear in home refrigeration and air-conditioning units. The twin drawbacks of rare materials and high power consumption are the areas in which these companies are most interested. Solving either, or both of them, would constitute a real breakthrough in science, with immediate applications in the military and commercial fields.

SUNDSTRAND . . . a primary source for constant frequency electrical systems!



Operator's console for one of the constant speed drive test stands at Sundstrand Aviation.



Sundstrand controlled-speed variable-displacement hydraulic motor with alternator—for use with Sundstrand hydraulic pump to provide controlled frequency electrical power.

Sundstrand constant speed drive for the Regulus II missile.

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IRE Makes Cash Awards For Six Technical Papers

Six cash prizes—$250.00 each—were awarded for outstanding technical papers given in Miami during the recent National Telemetering Symposium sponsored by the Professional group on Telemetry and Remote Control of the Institute of Radio Engineers.

The prize-winning papers are (in order presented at Symposium):

A transistor-driven Magnetic-Core Memory Using Non-Coincident Current Techniques, by R. L. Koppel, Lockheed Missile Systems Division.

A Transistorized Calibrator for Missile Telemetry, by Olin B. King, Army Ballistic Missile Agency.

Phase-Locked Demodulation in Telemetry Receivers, by D. D. McRae, Radiation, Inc.

New Design Philosophies in Dynamic Data Handling Systems, by Jerome J. Dover, Ampex Corporation.

Automatic Control of Power in a Scatter Communications System, by George S. Axelby and Eugene F. Osborne, Westinghouse Electric Corp.

Advanced Space Instrumentation Techniques, by R. V. Werner, Cubic Corporation.

All of the above papers are included in the proceedings from the meeting, obtainable from IRE's Professional Group on Telemetry and Remote Control.

In his paper on "A Transistorized Calibrator for Missile Telemetry," Olin B. King of ABMA described a transistorized in-flight calibrator developed for use with the *Jupiter* missile, and briefly discussed the requirements for in-flight calibration. The paper also outlined the history of calibration equipment used on the *Jupiter* as well as on the *Redstone*.

GE Continues Streamlining of Defense Electronics

Syracuse—A Defense Systems of General Electric Co. has been established by Dr. George L. Haller, general manager. This is the second major change in the division's structure in recent weeks. The first change involved dividing the Missile and Ordnance Systems Department into two separate operating units, the Missile and Space Vehicle Department and the Ordnance Department (m/r Sept. 22, p. 42).

The new department, Dr. Haller said will enable GE to focus top defense systems management and technical talent on fullfillment of advanced defense system requirements of the Army, Navy, and 2nd Air Force. The centralized systems organization is intended to respond to urgent Department of Defense requirements.

Richard L. Shelter will head the organization. Shelter was manager of GE's Missile Guidance Section in Syracuse heading design and development of the *Atlas* guidance system.

Dr. Haller announced the appointment of Hillard W. Paige as general Manager of the newly formed Missile and Space Vehicle Department in Philadelphia. Paige was manager of GE's Nose Cone Section.

ITT Consolidates Two Electronics Divisions

The consolidation of two of its divisions—both in the electronics manufacturing field—has been announced by International Telephone and Telegraph Corporation.

The two divisions are Federal Telephone and Radio Company of Clifton, N.J., and Farnsworth Electronics Co., of Fort Wayne, Indiana. Headquarters will be at Clifton, with manufacturing operations maintained at both places.

Fred M. Farwell, executive vice-president of ITT's United States group, said "The move is another step in ITT's organization program for its American companies. Both have had close similarity in their products and capabilities, and their markets have coincided to a considerable extent."

Delbert L. Mills, President of Federal Telephone and Radio, will head the single management of the new division. Vernon L. Haage vice-president of Farnsworth missile test equipment section has been named general manager of the Fort Wayne operation.

Reader Interest Surveys to be Taken for m/r

In line with m/r's policy of continuous improvement of editorial content, AMERICAN AVIATION PUBLICATIONS has retained Eastman Editorial Research Service.

This nationally known organization will make continuing, comprehensive studies to determine reader interest in editorial content.

Appraisal will be based on personal interviews with representaative subscribers who will be asked for opinions on each department, news and features articles. This will be evaluated by m/r editors whose aim will be to give you the best in your field of interest. Meanwhile, m/r welcomes, as always, the expression of views through letters of our readers.

Manpower Search Keys Telemetry Meet

The National Symposium on Telemetry in Miami again showed that high-level manpower is the most sought-after commodity in the electronics field. Technical papers, panel meetings, exhibits, and "shop talk" are all important, but the most emphasis is still put on "body-snatching" schemes.

Favorite topics at the meeting were salaries, lucrative fringe benefits, fat retirement plans, long vacations, stock option plans, profit-sharing incentive deals, and other subjects that might lure men—other companys' scientists and engineers—into the fold. And the favorite meeting spots were the plush suites or hospitality rooms run by the body-snatchers.

Except for a small number of companies heavily involved in major missile programs, recruiting was confined to a search for experienced specialists. This pattern was set at the Institute of Radio Engineers National Convention in New York last spring. There, company officials agreed that high-level talent was hard to come by, but that inducements besides salary might be of some help.

There are mixed feelings on this type of proselytizing. The unhappy employee is all for it, while the employer with a heavy work schedule ahead of him cannot afford much in the line of personnel shifts. One of the employers put it this way: "After every convention, my company cringes waiting to see who it lost or hired."

The matter was also of great concern to the symposium committee. Chairman of Public Relations, C. H. Hoeppner of Radiation Inc., stated it in the follows words: "This thing is getting bad enough to actually impede the national defense. A great number of top-notch people only remain with a company for a relative short period of time, and just as they are about to get their feet wet, some other company comes in and hires them away."

There is, however, one bright side to the picture. The *most* desirable men are already comfortably slotted in top spots with their present employers, and are loathe to leave, even for attractive incentive offers.

Space Reconnaissance

The development of a dynamic analyzer to improve the reliability of reconnaissance equipment aboard a space vehicle was disclosed today by the Air Research and Development Command (ARDC). This prototype model tests camera systems under simulated flight conditions. A production model is slated for completion by early 1960.

Temco | AIRCRAFT DALLAS

Making major breakthroughs in brazing stainless sandwich

Two radically new process developments by Temco Engineering may well revolutionize the entire concept of fabricating stainless steel honeycomb structures. One is "Temcombing," Temco's *continuous process* of stainless sandwich fabrication. The other is a simplified "Two-Phase" method for brazing stainless honeycomb structures. Patents now are being applied for on both of these processes.

Conventional, time-consuming batch brazing methods seem primitive compared with Temcombing. Panels of virtually unlimited size now are feasible in place of small, batch-made panels, thus reducing weight and critical tolerance errors. After lay-up, finished Temcomb panels can be turned out at rates up to 18 inches per minute, and at considerably *lower costs than by batch methods.*

Temco's exclusive Two-Phase resistance brazing method eliminates the need for furnace operations. For complex shapes, the Two-Phase process is the fastest and most advanced developed to date.

Advanced weapons systems, probing beyond Mach 3, demand whole new domains of materials and reliability. Temco engineering capabilities are meeting these demands with new developments and fabrication techniques in stainless steel, titanium, and other high-temperature materials. Pioneering in design, tooling and production for tomorrow's spacecraft industry is part of Temco's complete systems capabilities — all ready to meet *your* challenge.

TOMORROW'S NEED IS TODAY'S CHALLENGE AT..

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AIRCRAFT CORPORATION • DALLAS, TEXAS

Second Moon Probe Geared To Measure Radiation Belt

Optimum Time For Launching Air Force Vehicle—Early Morning, Oct. 11-13

An air of cautious optimism prevailed in Air Force circles as the second *Thor-Able* vehicle was readied at the Cape Canaveral range for another attempt at a lunar probe.

Unlike the first stage of its predecessor—a standard USAF *Thor*—the *Thor* set up for this second attempt was stock hardware, but a vehicle which has been the object of every refinement and double-check possible. Insofar as thrust, fuel and guidance are concerned no changes were indicated. No details were released officially on the instrumentation, prior to the shoot.

However, Dr. Herbert F. York, chief scientist for ARPA—the managerial agency for the last lunar probe—recently said the lunar probe was being reinstrumented to measure the van Allen radiation belt detected by *Explorer* I. Due to the critical payload weight limitations (about 32 pounds), possibly the magnetometer, which would measure the magnetic fields of the earth and the moon; or the scanner which was to provide a picture of the back side of the moon, would be eliminated to permit incorporation of the scintillometer which would measure the radiation.

Because of the intensity of the radiation indicated by *Explorer* I, as much as five pounds of lead shielding could be required to protect the instruments and reduce radiation penetration to a tolerable recording level.

In view of the possibility that the payload might impact the moon—one chance in four at best—this vehicle and those used in later lunar probes were sterilized to prevent any contamination of the moon.

No definite announcement was scheduled prior to the actual attempt, but the optimum times for the shoot were known to be the early morning hours of October 11-13.

Caution—lightly seasoned with optimism—would better describe the general atmosphere at the Florida base as military and civilian technicians and scientists worked feverishly to ready the vehicle.

Maj. Gen. Donald Yates, commanding officer of the Atlantic Missile Test Range, said steps have been taken to remedy the malfunction which caused the first lunar probe vehicle to blow up 77 seconds after it lifted off the pad August 17.

The attempt, coming so soon after transfer of the project from the military to the National Aeronautics and Science Administration, meant that essentially there could be little difference in the overall handling of the attempt.

Third and final Air Force attempt to get off a lunar shot will be made on or about November 8, at which time AF technicians feel they will have accomplished a complete check-out.

NASA Begins Operation With Some Areas Vague

As an organization, the newly-created National Aeronautics and Space Administration apparently is off to a good start, with the naming of top management personnel and the assignment of particular space projects.

But in the "gray areas" of military vs. civil responsibilities, many projects still await Presidential decision. By executive order, Department of Defense has transferred to NASA:

1. Project Vanguard team with about 150 persons, including Dr. John P. Hagen, director. This transfer was forecast several weeks ago by m/r.

2. The four remaining lunar probes (two Air Force, two Army), plus three satellite projects assigned to Army Ballistic Missile Agency. This includes two inflatable spheres—one 12' in diameter, the other 100' in diameter—and a cosmic ray satellite. These transfers also were forecast by m/r.

The order switched from the military (principally Advanced Research Projects Agency) a total of $117 million, bringing NASA's budget to $301 million, with about $250 million programmed for space projects.

NASA also got research programs in such areas as nuclear rocket engines, high-performance fuel (fluorine, hydrogen, etc.), and responsibility for developing a one million pound thrust single chamber engine.

Still to be decided are program responsibility—military or NASA—for a 1.5 million pound thrust engine using *Jupiter* clusters; and cognizance over navigation, communication and weather satellites. "Men in Space" programs will be joint endeavors.

• **Key men named**—Five days after NASA took over responsibilities of NACA, Administrator T. Keith Glennan announced key appointments. With the exception of three persons, all were elevated from existing NACA personnel.

The new appointees included Albert W. Siepert as director of business administration, Homer E. Newell, Jr., as assistant director for advanced technology; and Abraham Hyatt, assistant director of propulsion. Siepert was executive officer, National Institutes of Health. Newell was program coordinator for Vanguard project; and Hyatt was chief scientist, research and analysis office of Bureau of Aeronautics.

Also named as directors and reporting to Glennan were Dr. Abe Silverstein, director of space flight development (from associate director at Lewis Research Center); John W. Crowley, Jr., director of aeronautical and space research (from NACA associate director for research).

Dr. John F. Victory, executive secretary of NACA, was named an assistant to the administrator.

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when and where

ASME, Lubrication-ASLE Conference, Statler Hotel, Los Angeles, Calif., Oct. 14-16.

The British Interplanetary Society, Space Medicine Symposium, The Great Hall, BMA House, Tavistock Square, London, W.C.1, Oct. 16-17.

URSI, IRE, USA National Committee Joint Meeting, Pennsylvania State University, University Park, Penna., Oct. 20-22.

Association of the United States Army, 1958 annual meeting, Sheraton-Park Hotel, Washington, D.C., Oct. 20-22.

Sixth Annual USAF Weapons Competition, Interceptor Phase, Air Defense Command, Tyndall AFB, Fla., Oct. 20-30.

Fifth National Vacuum Symposium, Sir Francis Drake Hotel, San Francisco, Calif., Oct. 22-24.

Fourth Annual Symposium on Aviation Medicine, Miramar Hotel, Santa Monica, Calif., Oct. 22-24.

Fifth National Vacuum Symposium, Sir Francis Drake Hotel, San Francisco, Calif., Oct. 22-24.

IRE, 1958 National Simulation Conference, Professional Group on Electronic Computers, Statler-Hilton Hotel, Dallas, Texas, Oct. 23-25.

AIRBORNE DIGITAL ELECTRONIC COMPUTER WILL "TAKE OVER" FOR PILOT, NAVIGATOR AND BOMBARDIER ON NAVY'S NEWEST JET BOMBERS. The crowded quarters of carrier-based aircraft leave little room for electronic "brains"—a scant few cubic feet in the case of the Navy's requirement for its AN/ASB-8 program: a package computer capable of target-approach pilotage, navigation and precision bombardment. And that's just what Burroughs, working closely with the Naval Ordnance Test Station, China Lake, is doing—cutting a roomful of equipment down to size. Burroughs Corporation, 6071 Second Avenue, Detroit 32, Michigan.

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Four or More U.S. Missiles Arm Forces Facing Red China

Atomic Weapons Included in Available Arsenal

special report to m/r

TAIPEI—American forces in the Formosa area have as varied a supply of missiles and rockets as any power in the Far East, ally or enemy.

First missiles to appear on Taiwan were the subsonic *Matadors,* which the United States brought in last year. American experts set up bases along the 250-mile western coastline of Formosa, facing Communist China, and the *Matadors* have been operational for some time. This ground-to-ground missile should prove extremely effective if the Communists attempt invasion of this island fortress.

The Reds have been complaining bitterly about the Nationalist use of the heat-seeking air-to-air *Sidewinder,* which has proved so successful in recent jet air battles between Nationalist Sabre-jets and Red-built Mig 17's flown by Chinese Reds.

The *Sidewinder* is also used by the American 83rd-fighter Interceptor squadron from Hamilton Field, California, with its record holding F-104's.

These aircraft were flown to Formosa aboard C-124's, and first aircraft equipped with *Sidewinders* were operational within 24-hours arrival.

• Arrival of ***Nike***—Big news from Taipei, for both Communists and Nationalists, was the arrival of the *Nike-Hercules* missile on October 8.

The Vinnell Corporation has been in a crash program for weeks building launching pads above ground, as against normal subterranean installations. These pads will be turned over to American military men by October 15, and units should be operational by the end of the month.

Nike-Ajax, with its "powder and ball" warhead, was considered sufficient for this area at one time. However Washington changed this thinking and set up the atomic warhead *Nike-Hercules.* A second missile battalion, of the 71st Artillery Regiment, is on way from the United States to take over setting up and operating the *Nike* bases.

A big factor in the defense of Formosa is the Seventh Fleet, which the United States has committed to protect Taiwan and the Pescadores.

The 155-ship Fleet is well provided with many types of rockets and missiles. The cruisers "Los Angeles" and "Helena" have *Regulus* I, which can be fitted with an atomic warhead.

There are four aircraft carriers in the Fleet, three with attack missions and the fourth an anti-submarine unit.

Aircraft on these vessels undoubtedly have the infrared-eye *Sidewinder,* which seeks out the greatest heat source in its target and aims itself into the enemy aircraft's tailpipe.

American fighters and interceptors are also equipped with 2.75-millimeter *"Mighty Mouse"* rockets, which can be fired singly or in selective salvos.

There has been no information that either the Nationalist Chinese or Americans have the Hughes *Falcon* missile, although it is more efficient than the *Sidewinder.*

The Navy has advised that it doesn't have destroyer escort rockets which proved so effective in Korea—but indications are they'll be sent out if needed.

• Atomic Factors—There's a little known, but seriously considered factor in the use of *Nike-Hercules.* Washington officials feel that when a missile is fired at an approaching enemy plane, even such aircraft as are not damaged by the atomic explosion will be unable to return to base.

Experts say that enemy survivors of such a blast will be so frightened, they'll develop psychosomatic radiation sickness, self-induced by that very fear. First symptoms of radiation sickness are extreme dizziness and vomiting, which should make enemy crew members incapable of operation of their aircraft.

Vice Admiral Wallace Beakley, outgoing Commander of the Seventh Fleet, ruefully admitted he's called "Atomic Admiral and Warmonger" by Chinese Communists. But, in a recent interview, he stated that he is totally ready to go to the ultimate expense in combat—that is, totally ready if ordered to use atomic weapons.

These weapons are cheaper in the long run, he believes.

He disclosed that he has partially assembled atomic weapons aboard vessels of his Fleet, but considered them a precaution against fatal delays if the Formosa Straits should suddenly erupt into total war.

With *Mighty Mouse, Sidewinder, Regulus* I, *Matador* and *Nike-Hercules,* well deployed in the Taiwan area, our forces and forces of our Allies are well prepared to wage any type war which the Communists might choose.

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233) SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION OF

MISSILES AND ROCKETS, published weekly at Harrisburg, Pennsylvania, for October 13, 1958.

1. The names and addresses of the publisher, editor, executive editor, and business manager are: Publisher, Wayne W. Parrish, Washington, D.C.; Editor, Eric R. Bergaust, Washington, D.C.; Managing Editor, E. E. Halmos, Washington, D.C.; Business Manager, Leonard Eiserer, Washington, D.C.

2. The owner is: American Aviation Publications Inc., 1001 Vermont Ave. N.W., Washington 5, D.C. Stockholders owning 1% or more of total amount of stock: Wayne W. Parrish, Washington, D.C.; Leonard A. Eiserer, Washington, D.C.; Eric Bramley, Washington, D.C.; Jay Shuler, Springville, N.Y.; Robert R. Parrish, Chicago, Ill.; E. J. Stackpole, Harrisburg, Pa.; Fred S. Hunter, Los Angeles, Calif.; A. H. Stackpole, Harrisburg, Pa.; Erik Bergaust, Washington, D.C.

3. The known bondholders, mortgagees, and other security holders owning or holding 1% or more of total amount of bonds, mortgages, or other securities are: None.

4. Paragraphs 2 and 3 include, in cases where the stockholders or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed through the mails or otherwise to paid subscribers during the 12 months preceding the date shown above was: 23,347.

LEONARD EISERER,
(Signature of business manager)

Sworn to and subscribed before me this 3rd day of October, 1958.

HELEN M. DES PREZ,
Notary Public.
(My commission expires November 30, 1961)

Vitro, Koppers Sign "Joint Venture" Agreement

Officials of Vitro Corp. of America and Koppers Co. Inc. announced the signing of a Vitro-Koppers "joint venture" agreement that will enable the two companies to team in undertaking weapon systems work for the Department of Defense.

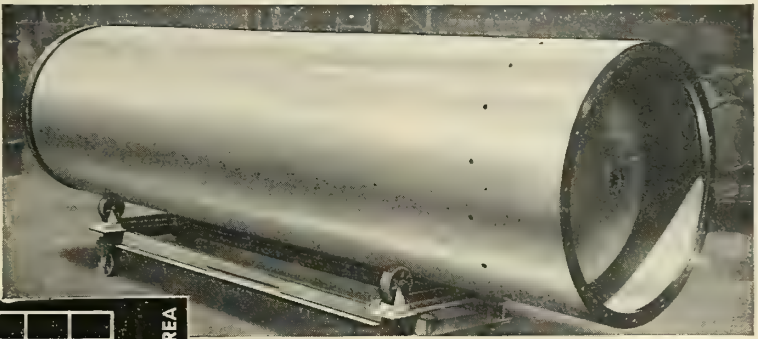
The Vitro-Koppers team will undertake all phases of weapon systems work from research and development through large-scale manufacture. The companies will seek contracts for missile ground support equipment, as well as for the design and production of complete weapon systems, according to a spokesman.

Koppers' Metal Products Division operates three manufacturing plants in the Baltimore area, in addition to a plant in Philadelphia.

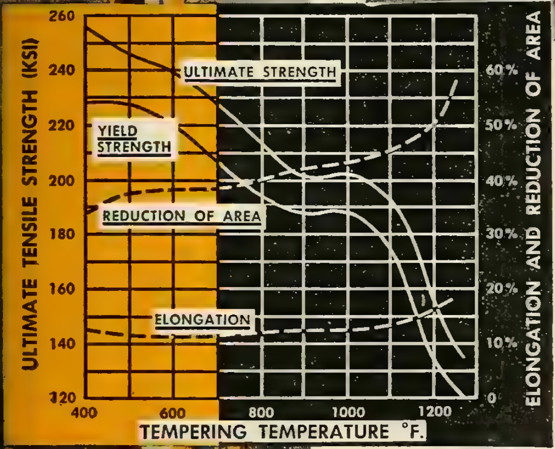
Vitro owns the research and development facilities of Vitro Laboratories in Silver Spring, Md. and W. Orange, N.J.; the electronic production facilities of NEMS-Clark Co., Silver Spring, Md.; and the aircraft and armament production facilities of Thieblot Aircraft Co., Martinsburg, W. Va.

Newest advance in missile tankage

A. O. Smith flash-welded and fusion-welded units have exceptional strength . . . can be furnished in sizes and configurations to meet your designs exactly



Typical missile propellant tank as produced by A. O. Smith. Diameter is 40", length 28'. The highly stressed longitudinal welds in the "roll and weld" fabrication method can be flash-welded for higher strengths.



Materials are available which will produce properties indicated above. Current lightweight, high-strength propellant tanks are being produced in the strength range indicated by the yellow area of the chart.

Here's a new opportunity to gain wider design latitude. A. O. Smith can fabricate liquid or solid propellant tanks (cylindrical or spherical) and pressure tanks to practically any chamber size.

A. O. Smith has produced tanks with guaranteed minimum yield strengths of 190,000 psi. . . . wall thicknesses from .050"-.220" . . . diameters over 50" . . lengths to 28'. Proposed designs and recent fusion weld developments indicate minimum yield strengths of 210,000-225,000 psi are attainable in weld areas.

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AERONAUTICAL DIVISION
Milwaukee 1, Wisconsin
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missile people in the news

West Coast Electronics Announce Job Shifts

Electronics companies in the San Francisco Bay area have announced a series of appointments and other executive changes.

Varian Associates have appointed **T. L. Allen** as manager of magnetometer products development, and **Richard M. Whitehorn** to the new position, research manager of radiation. **Dr. William J. McBride,** manager of the radiation division, said the creation of the research department is a planned step in the division's growth pattern.

Eitel-McCullough, Inc., San Carlos, has created a new post in the office of the president—assistant for management planning—and named **Jack Gilpin** to that post.

Robert Scal, vice president and general manager of R/S Electronics Corp., has announced a reorganization of its Palo Alto plant with creation of three operating divisions.

Scal heads the production division with responsibility for all manufacturing. R/S Electronics is a subsidiary of Regan Industries, Inc., San Bruno, manufacturer of amplifier-receiver systems for aircraft, missiles and radar.

Clinton O. Lindseth, formerly chief of the receiver section, heads the electronics division. **Wallace F. Burton,** formerly a senior project engineer in magnetic components, was appointed chief of the transformer division.

K. E. Hallikainen, president of Hallikainen Instruments, Berkeley, announced the appointment of **William F. Stairs** as production manager. Stairs previously was with Beckman Instruments and Tracerlab, Inc.

Roy Healy Heads Space Cluster Project

Rocketdyne has announced that **Roy Healy** is program manager on its contract to provide a space-mission propulsion cluster for the Army Ballistic Missile Agency. Healy also retains his duties as program manager for the U.S. Army *Jupiter* IRBM engine, the company announced.

The new system, scheduled for lunar probes and overseas operational use, will utilize a cluster of rocket motors like those of *Jupiter.*

Healy first became interested in rockets in the mid-20's and joined the American Society in 1935. He was twice elected ARS president—in 1942 and 1947. With the ARS Experimental Committee, Healy took part in pioneer work on oxygen-alcohol thrust chamber developments.

Sales

Burt L. Fielding has been appointed manager of engineering sales for the Electronic Systems Division of Dalmo Victor Company. Fielding will have responsibility for the division's sales functions, including customer liaison in cooperation with Dalmo Victor's director of sales, George Stewart. Fielding previously held the post of liaison engineer, with responsibility for military goods production at United Electro-Dynamics, Division of United Geophysical Corp.

Samuel Ochlis has been named sales manager of the Instrument and Equipment Division of Epsco, Inc., which designs and manufactures building blocks for large data handling systems. Prior to his new appointment, Ochlis was sales manager at Arthur C. Ruge Associates.

Industry

George Masurat was promoted to general superintendent of production for Philco Corp.'s Government and Industrial Division. In his new position, Masurat is responsible for production operations of the *Terrier* missile fuze, Transac computers, Signal Corps radio relay equipment and *Sidewinder* missile. Masurat has been with Philco since 1943.

Everett M. Patterson has been appointed vice president of Industrial and Defense Sales for the Bulova Watch Company, Inc. Patterson will continue to serve as president and director of the Bulova Research and Development Laboratories, Inc., posts he has held since September, 1957. Credited with many pioneering engineering achievements on jet engines and rocket propulsion control devices, Patterson was formerly affiliated with Bell Telephone Labs.

Advertising correspondence should be addressed to Advertising Sales Manager, Missiles and Rocket, 17 East 48th Street, New York 17, N.Y.

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advertiser's index

Aeronca Mfg. Corp.	3
Aeroquip Corp.	3
American Airlines, Inc.	47
American Potash & Chemical Corp.	1
Arnoux Corp.	
Astrodyne, Inc.	4
Avco Mfg. Corp., Crosley Div.	5
Burroughs Corp.	46
Cameron Iron Works, Inc.	15
Delco Radio Div., General Motors Corp.	8
Diversey Engineering Co.	7
Dow Chemical Co., The	32
Food Machinery & Chemical Corp.	34
Ford Instrument Co., Div. Sperry Rand Corp.	23, 24, 25, 26, 27, 28, 29, 30
General Electric Co.	17
Hi-Shear Rivet Tool Co.	52
L.O.F. Glass Fibers Co.	40
North American Aviation, Inc., Autonetics Div.	12
Ramo-Wooldridge Corp., The	20
Rucker Co., The	18
Ryan Aeronautical Co.	39
A. O. Smith Corp., Aeronautical Div.	49
Sundstrand Aviation, Div. Sundstrand Machine Tool Co.	42
Temco Aircraft Corp.	44
Voi-Shan Mfg. Co.	3

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- An unparalleled background in development and production of complex electronic and electromechanical systems, including guidance systems.
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- Experience. Crosley has and is proving itself on many projects, including some involving the *Falcon*, *Polaris* and *Titan* missiles; the MD-9 fire control system, research and development of the *Volscan* Air Traffic Control System, MPS-16 Height Finder Radar, missile and mortar fuzing, and structural components for missiles and supersonic aircraft.

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- 5% Chrome Die Steels
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ION ENGINE—ABMA's Stuhlinger Sees Barriers to Success—p. 20

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— 4

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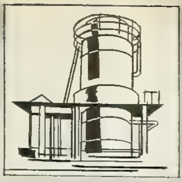

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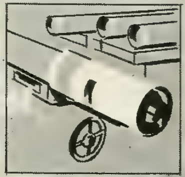
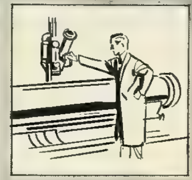


Steel—or fiber-glass —rocket cases for weight-savings



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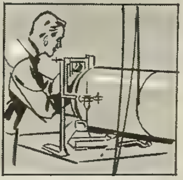

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Foresight which saw the coming of the Space-and-Missile Age enabled Goodyear Aircraft Corporation to begin construction—*more than ten years ago* — of what is today one of the most advanced and largest integrated rocket engine case facilities in the nation.

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Today's material requirements surpass anything envisioned 10 short years ago. Molybdenum and beryllium, for example, are still exciting metals with much promi for space vehicles and ultra-high-speed aircraft. It now appears, however, that the full promise of such metals may be fulfilled when they are used, not alone, nor as alloys, but when combined with other materials to form totally new types of structural materials.

Such a "marriage" of metals, ceramics and plastics is a promising approach to high-temperature problems that is being vigorously pursued at Avco. It opens new potential applications for many exotic combinations.

These bold steps forward are possible at Avco, where materials research include concurrent basic studies and applied research, plus developmental programs th extend through the solution of processing and testing problems.

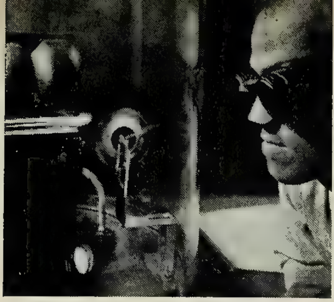
The search for new knowledge goes forward simultaneously with the creation advanced technology at Avco's Research and Advanced Development Division. Th creative man, whether he is interested in basic studies or practical problems, finds effort enhanced by the stimulus of interdisciplinary contact and feedback from other related fields.

Research and Advanced Development is more than a descriptive title at Avco. It is a concept that promotes creativity.

Avco

Research and Advanced Development division

For information on unusual career opportunities for exceptionally qualified scientists and engineers, write to: Dr. R. W. Johnston, Scientific and Technical Relations, Avco Research and Advanced Development D 201 Lowell Street, Wilmington, Mass.



COVER: *Miniature laboratory ion-propulsion model, operating at near vacuum conditions in NASA's Lewis Research Center, produces thrust which propels the small wheel behind the jet. ABMA's Dr. Ernst Stuhlinger (see page 20) discusses barriers which must be overcome before ion engines can become a reality.*

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in this issue

OCT 20 HEADLINES

Second Lunar Probe Termed "Successful"
Although it meets fiery death, valuable data furnished for scientists at extreme altitudes 13

Boeing Wins *Minuteman* Competition
Selected from 18 competitors, growing missile business seen for airframe firm after B-52 phaseout 14

Convair's Lobber Development
Small cargo missile could be counterpart to Army Ordnance's proposed Project *Adam* 15

Dr. Ernst Stuhlinger
"Mr. Ion Engine" discusses barriers that must be overcome before engines are operational 20

Liquid Scale-Up: Step to Space
Propulsion Editor Albert J. Zaehringer gives rundown on how *Jupiter* will be clustered for 1.5 million pounds of thrust 27

Space Can be Liquid
Industry help needed, Navy Admiral says, in missile submarine threat 37

Coal's Place in Space Age
Hydrocarbons from low temperature coal tars appear promising for higher propellants 43

Assembly of *Thor* Engines
New production techniques makes assembly line technique feasible for Rocketdyne engines 50

MISSILE ELECTRONICS

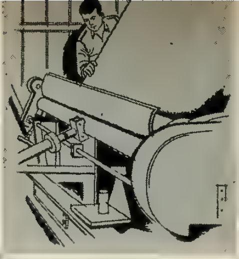
Thompson Products-Ramo merger
The story behind the transfer of stock 77

Painted Sphere to test Radiation Belt?
Doubtful that lunar probes can do the job alone 78

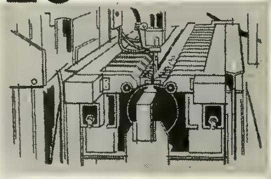
DEPARTMENTS

Washington Countdown .. 9
Industry Countdown 11
Space Age 52
Missile Business 55
Contract Awards 56
New Missile Products ... 59
Soviet Affairs 70
Moscow Briefs 72
When and Where 75
Missile Electronics 78
Keeping Track 83
Editorial 90

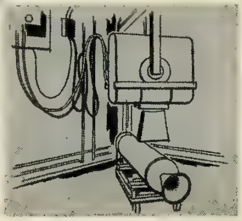
CAPABILITIES AND FACILITIES



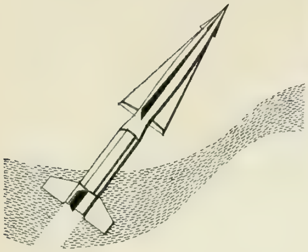
New methods in forming rocket motor body shell.



Welding facilities assure strong, uniform welds.



Xray-inspection before annealing.



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STRAIGHT TALK TO ENGINEERS

from Donald W. Douglas, Jr.

President, Douglas Aircraft Company

You may wonder what the future holds for the engineer who decides to build his career in the aircraft/missile industry.

In terms of permanent demand, this industry probably requires a greater proportion of engineers to total personnel than any other. Here at Douglas we are now employing more engineers than we did during World War II.

In regard to professional standing, the aircraft/missile industry deals always with the latest state of the art in every engineering and scientific specialty involved. Its engineers are in one of the best informed and highest prestige fields in their profession.

Whatever your present activity, if you decide to move into aircraft, missile and space technology, we would like to talk with you.

Please write to Mr. C. C. LaVene,
Douglas Aircraft Company, Box 620-R,
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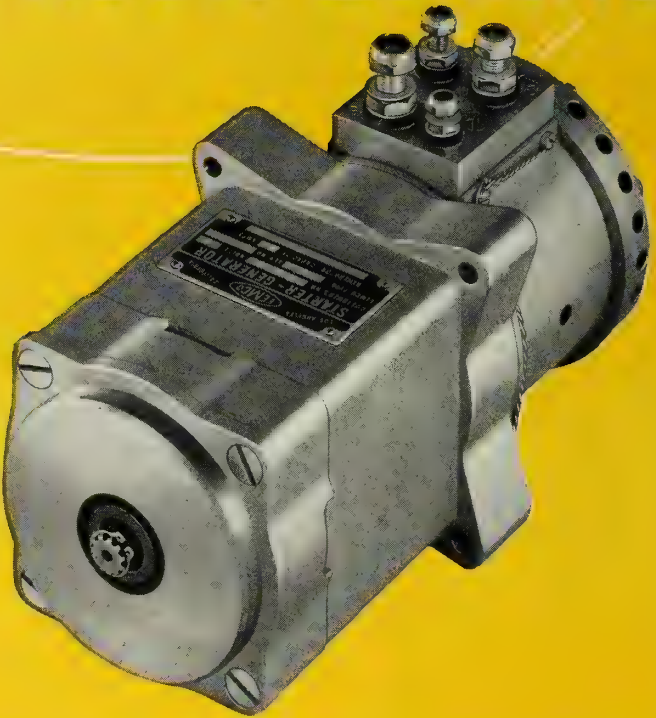
MISSILE PRECISION for a MOTOR TRUCK ENGINE



EEMCO Starter-Generator Type D-1025 Chosen for New Turbine Truck Engine

When one of the largest motor truck manufacturers developing a new type turbine truck engine requested EEMCO to design a starter-generator for the engine, it was recognition of the power, precision and reliability that is built into such EEMCO products. Now in an advanced stage of development, this new turbine engine may revolutionize the entire motor truck industry. EEMCO is proud to participate in this type of "revolution."

For years, EEMCO has been a specialist in the design and manufacture of special motors and actuators for the aircraft and missile industry. Now EEMCO's starter-generator Type D-1025 is an example of EEMCO's flexibility in related fields. EEMCO motors or actuators are on the majority of the latest missiles and supersonic military aircraft for these reasons:

1. Sixteen years of continuous experience in research and development, as well as exhaustive environmental and performance testing, assure maximum reliability of all EEMCO products.
2. Ratio of output to weight is extremely high in all EEMCO units.
3. Production schedules are met on time under stringent military specifications that require the most precise tolerances and performance.

EEMCO starter-generator Type D-1025 is an example of such precision manufacturing. Scores of other EEMCO products have been designed and produced for special uses. Your inquiry is invited.

SPECIFICATIONS FOR EEMCO STARTER-GENERATOR TYPE D-1025

Starter performance: Breakaway torque of 220 inch-pounds with terminal voltage of 20 volts.

Generator performance: Delivers 40 amps continuously with intermittent peaks up to 80 amps at 28 volts.

Weight: 14½ pounds.

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the missile week

washington countdown

Contrary to popular . . .

opinion, one high Washington source told m/r that Air Force and Army are not competing on a time schedule as to who will make the next lunar probe. Army picked its own dates—most probably December for the first try—because it was tied up with *Explorer*. Reason: Gen. J. B. Medaris did not want undue public pressure on his team.

Air Force was assigned . . .

two "space probes" in addition to three lunar probes several months ago by ARPA's Roy Johnson. The order said "get two *Thor-Ables* ready," and AF would receive later instructions on where to send them. It doesn't mean Venus either, although the planet is astronomically ripe in June, 1959; while Mars will not be in position until November, 1960.

Second generation *Polaris* . . .

missiles are a dime a dozen, insofar as studies and proposals are concerned, according to a top Naval source. Code name *Atlantis* has been mentioned, but it's one of two dozen similar studies.

The three R's . . .

Dr. James R. Killian says, should be actively expanded to include L, M AND S—languages, mathematics and science. They've been neglected, and emphasis on them could strengthen the free world and provide a better standard of living for all men, he added.

A local storm . . .

prevented planned photography on the Oct. 12 eclipse. But the National Academy of Sciences-sponsored expedition managed to launch five *Nike-Asps* and one the following day. The sixth rocket was fired to compare normal conditions with those existing during the eclipse.

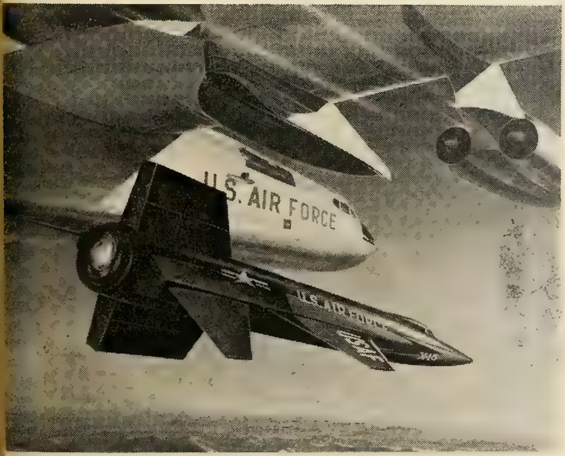
Pioneer was successful . . .

and NASA apparently is a little embarrassed by the publicity it got as "administrative agency." The facts: Hardwork of coordinating and insisting on every possible checkout of all components was by ARPA, with NASA getting in on the act only days before launch.

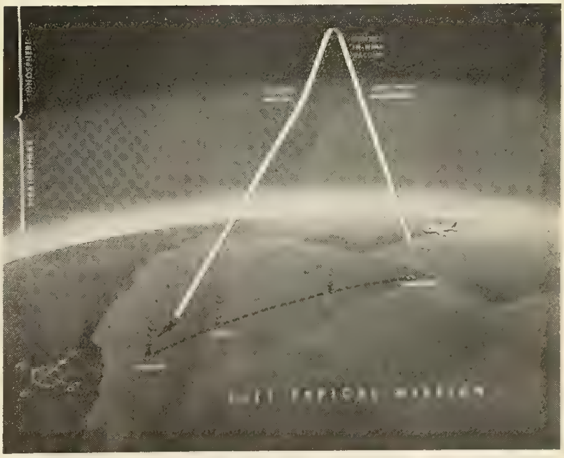
Use of Sidewinders by Chinese . . .

which set Peiping to shouting "dirty pool" at Washington, racked up high batting average for the Nationalists pilots. Out of the first six fired, four were definite kills. The other two were fired before Chiang's fighters were within range.

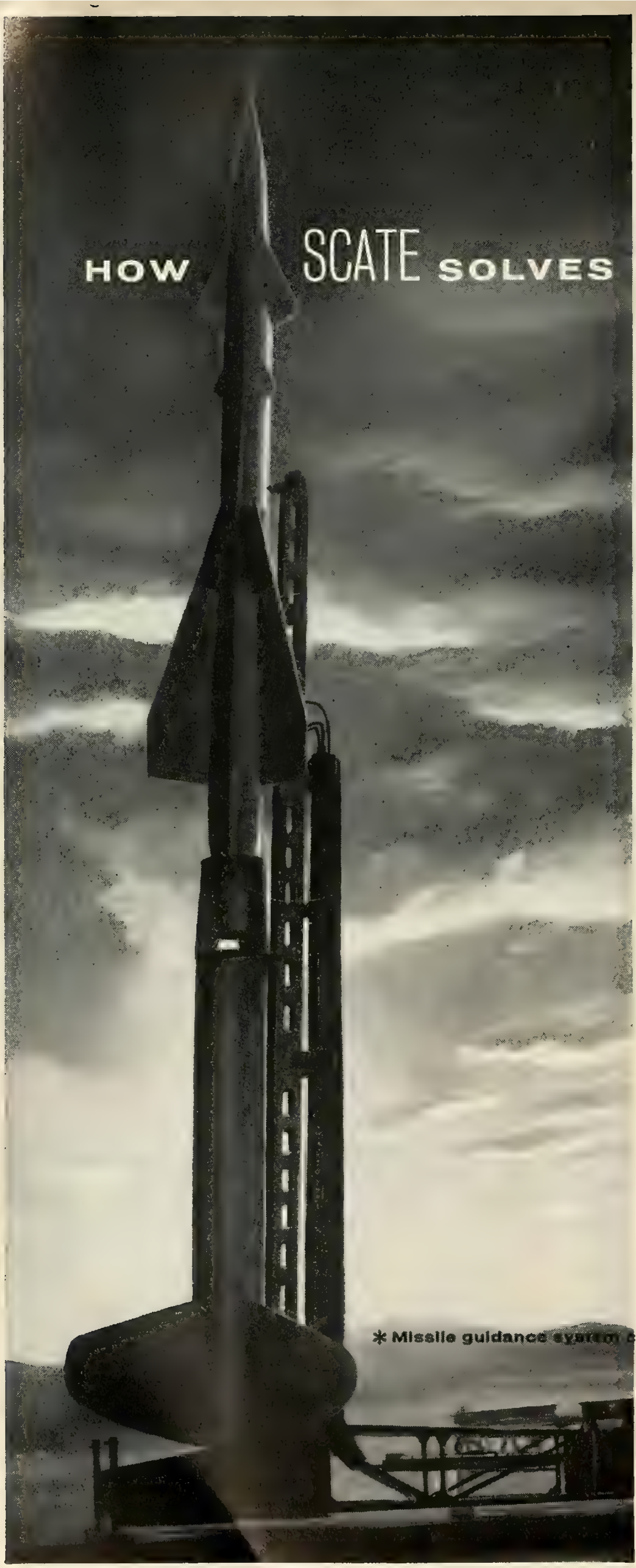
Air Force Unveils X-15—First Space Ship



RELEASE from mother aircraft.



FLIGHT trajector over range (see p. 84).



HOW SCATE SOLVES 2 BASIC PROBLEMS in testing electronic systems

Many complex electronic systems—missile guidance is a good example—may require testing that takes days by conventional methods. Yet the end function of such a system may last only a few minutes—**even seconds.**

Other systems, though less complex, must be tested in such large numbers that adequate personnel are frequently unavailable to perform tests by conventional means.

The SCATE system of automatic test equipment can solve **both** problems. It provides **self-checking** automatic testing which is **fast, flexible** and **foolproof.**

The system evaluates all important parameters of equipment under test, including:

1. RF sensitivity, center frequency, band width, power output, noise figure.
2. Audio frequency gain, band width, power output.
3. Video pulse circuitry, including pulse decoding, logic, digital comparison, pulse delays.
4. Voltage levels, DC and AC.
5. Servo response.
6. Mechanical response.

Stromberg-Carlson has standing designs for all the standard components which go into a SCATE system, and is fully experienced in designing custom components which may be required in any test system.

Complete details on the SCATE system and other Stromberg-Carlson automatic test equipment are available on request.

*** Missile guidance system can be tested automatically by the SCATE system.**

"There is nothing finer than a Stromberg-Carlson"

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industry countdown

Boeing has accelerated . . .
its missile expansion program in preparation for possible awards on the *Dyna-Soar* and air-to-surface weapon systems. The company is currently undertaking one of the biggest engineer recruitment drives in history with the Pilotless Aircraft Division striving to hire 1,200 engineers before the end of the year. In addition to the possible *Dyna-Soar* program, Boeing is producing the 250-mile *Bomarc* and has been awarded a contract for development of a 400-mile plus version of the same missile.

Missiles have boosted . . .
Temco Aircraft Corp's earnings for 1958 to nearly 10% above 1957 income. Temco, currently in a development program on the *Corvus* air-to-surface missile, expects its business to be half airframe and half electronics and missiles by 1961.

Missile industry veteran . . .
Northrop in the meantime has shown a much greater earning record again as a result of increased missile orders. With approximately 60% of last year's backlog in electronics, unmanned aircraft and missiles, earnings jumped 23 percent above the preceding year. Major projects include the *Snark, Hawk,* target drones, and research and development contracts involving missiles and space craft.

Cryogenics is receiving . . .
widespread applications in the field of infra-red guidance systems and is providing a large income to such companies as Air Products and the Linde Division of Union Carbide, leading research groups, and Arthur D. Little and Perkin-Elmer Corp. producers of cryostats for laboratory and military use. Cryogenics, essentially a fractional distillation for obtaining very low temperatures, although in use for many years for the manufacture of ammonia, is now receiving an immediate military application in the solid state cooling of infra-red devices for increased sensitivity.

A billion dollars . . .
in extra missile and aircraft funds, provided by Congress, will not be spent at this time according to acting Defense Secretary Donald A. Quarles. Slated for such programs as the *Hound-Dog* air-to-surface, *Polaris* IRBM, *Minuteman* ICBM, and the KC-135 utilization of the funds will depend on rate of development of the individual systems. In addition, the Secretary emphasized that no ceiling would be placed on the 1960 budget request leaving all three services free to request additional monies as needed to support next year's defense program.

Chemical milling . . .
of component parts of the *Atlas* with a resultant weight savings of approximately 500 pounds has added an additional 100 miles to the range of the ICBM. New light-weight construction techniques utilizing the dynamic etching process for the thrust cylinder, fairing and nacelle sections of the missile have been developed since the time the original *Atlas* design was formulated.

MIS (Man In Space) . . .
for placing a man in orbit for 24 hours or approximately 10 to 12 orbits of the earth, currently has $40-million available for getting it underway. First companies to profit are General Electric (Philadelphia) and North American Aviation, selected out of five firms involved in a 90 day study and feasibility programs. To date program is the sole development responsibility of the Air Force with management responsibility still in the area of indecision. ARPA feels the project, in any analysis, is a military project. NASA is of the opinion that the first phases of the project are of a scientific nature with future military responsibility. NASA further contends that whatever project their agency is involved in can eventually be utilized for military applications.

Nike-Zeus . . .
will, for all practical purposes, be an almost fully automatic electronic weapon system only calling on men for maintenance and logistics. One of the most important components of the system will be the acquisition, identification, and tracking systems. Some $20-million of the recent $135-million contract will be spent on the development, production and maintenance of several missile computers —an award received by the Remington Rand Univac Division of Sperry Rand Corp. The computers will be three times as fast as any comparable computers now in existence.

Thiokol Chemical Corp. . . .
reportedly has received contracts totalling $1.5-million from the Navy for packaged liquid propellant rocket engines. The awards are unofficially reported in connection with the *Bullpup* air-to-surface missile. A solid propellant auxiliary power unit will be demonstrated by Thiokol at the annual meeting of the ARS November 17 in New York.

BRUNSWICK'S *SBP* SAVES POWER FOR THE PAYLOAD

A unique advantage of Brunswick's Strickland B Process (SBP) is weight savings in missile and aircraft components. Consequently, there's more power for the payload weight. SBP, a unique machine method, maximizes laminated strength, even for extremely high temperatures, by precise orientation of juxtaposed fiberglas to points and kinds of stress. The use of SBP filament-wound laminate results in the highest strength and stiffness characteristics possible, and absolute minimum weight. Brunswick's SBP also produces a laminate that meets rigorous space age specifications for close tolerances and precision. It is a method that allows mass production by fully automated machines, as well. More and more designers are turning to SBP laminates for use in new designs now on the drawing boards. Brunswick, a leader in research and development, can also help *you* find new uses for SBP laminates in the design, fabrication or testing stage. Write The Brunswick-Balke-Collender Co., Defense Products Div., 1700 Messler St., Muskegon, Mich.

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OCTOBER 20, 1958
VOL. 4, NO. 16

missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

AF Alters *Pioneer* For Third Moon Try

by William O. Miller

Cape Canaveral—Not withstanding the unprecedented achievements of the October 11 attempted lunar probe, the Air Force is far from satisfied and is giving the entire vehicle a complete reappraisal.

Pioneer failed to follow the predicted trajectory because the first stage of the Douglas *Thor* burned three seconds too long. The thrust gave the first stage too much loft and it fell short—by 850 feet per second—of attaining the programmed speed. The guidance system failed to correct a 3.5 degree error in angle.

While pleased with *Pioneer's* 43-hour trip into cislunar space, AF officials say it just didn't work well enough and did not do what it was supposed to do. As a result, a number of changes before the next attempt are being considered, including possible changes in the payload and Alterations in the thrusts of the various stages.

Meanwhile, the AF is striving towards a more successful attempt in November. Since the moon completes and orbit of the earth each 27.3 days, the next attempt would be made about noon, November 7.

Despite the accomplishment, the National Aeronautics and Space Administration would not predict whether Army or Air Force would make the next probe attempt.

The November shoot would be the third and final lunar probe which the Air Force is authorized to carry out under supervision of NASA.

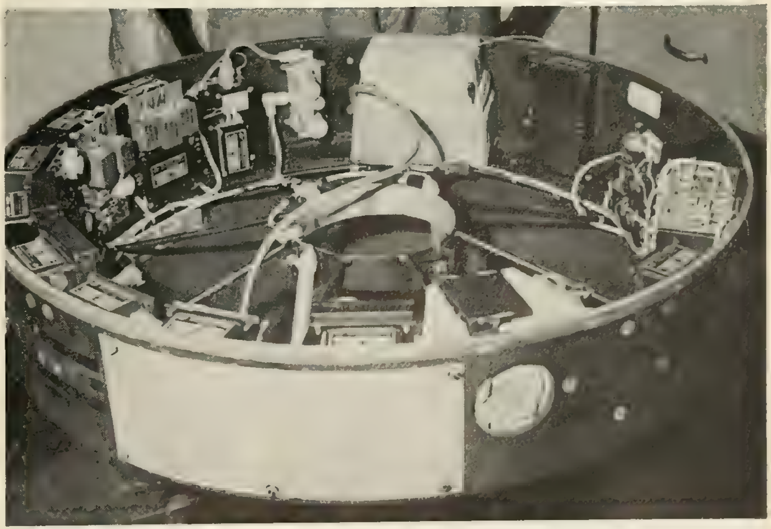
However, the total number of probes probably will be raised. Indications are that the Air Force will make the November attempt as anticipated and the Army's first attempt—of two authorized—will be made with a modified *Jupiter* in the first week in December.

Maj. Gen. John B. Medaris, commanding general of the Army's Ordnance Missile Command said the Army plans to apply a corrective in the flight trajectory from the ground, and he believes the probe has a 50-50 chance of success.

If such correction could have been applied to the Thor-Able, chances are that the unplanned high angle would

(Continued on page 14)

LAWMAKERS JOIN MILITARY AND SCIENTISTS in jubilantly discussing details of *Pioneer's* top-like fourth stage, (L. to R.) Maj. Gen. Donald N. Yates, commanding general AF Missile test Center, Rep. Joe Kilgore, Texas; Rep. James G. Fulton, Pennsylvania; John Truesdale, NAS; Col. H. H. Eichel, AFBMD; Dr. Abe Silberstein, NASA; and Brig. Gen. O. J. Ritland, AFBMD.



INSTRUMENT PACKAGE OF *PIONEER'S* fourth stage was designed to provide five types of information, including radiation, gravitational fields of earth and moon, temperatures, meteorite impact and a TV picture.

have been normal and the correct velocity—35,250 feet per second—would have carried *Pioneer* to a 50,000 mile vicinity of the moon.

• **Angle detected**—The erroneous high angle was suspected by trackers within three hours after blast-off. However, only raw data had been received from the five channels on which *Pioneer* was transmitting, and it took six hours before a crude trajectory could be plotted.

Pioneer almost "floated in space" for some two hours when it reached altitude of 79,212 miles above the earth's surface. Gravity was estimated at only four-hundredths of the gravity on the earth's surface.

Instrumentation weighed 39.6 pounds in five major packages:

1. An ion chamber to measure total incident radiation. Instruments were calibrated to measure the extremely high readings anticipated thereby eliminating weight-costly lead shielding.

2. A magnetometer to measure the gravitation fields of the earth and the moon.

3. Temperature gauges to determine internal temperature levels and to determine if fluctuations affected the instrumentation.

EIGHT VERNIER ROCKETS of third stage adjust its speed after separation.

4. Instruments for measuring micrometeorite impacts.

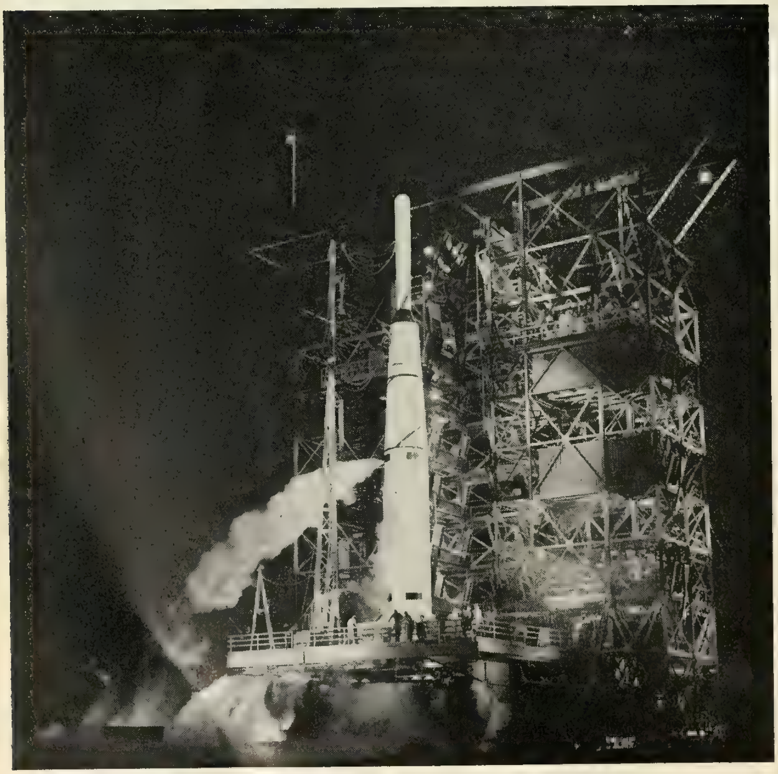
5. A TV-type scanner to provide a crude picture of the moon's surface. The scanner was not activated because it was tied to firing of the terminal stage.

To permit incorporation of the ion chamber which provided for radiation measurement, one or two levels of sensitivity previously planned was eliminated. This was considered one of the most important kinds of information sought, as preliminary *Explorer* findings had indicated radiation might prove a barrier to human entry into space.

However, telemetered data from *Pioneer* indicated a passenger aboard would have experienced less than 50 roentgens. The tolerable level is well above this. The radiation counter showed the rate was four roentgens per hour at 5,000 miles, three per hour at 10,000 miles, and two per hour at 17,000 miles.

• **Button not fired**—The button which would have fired the terminal rocket was never fired because of a battery "freeze up." If all had gone well, the solid propellant payload rocket would have been fired from Hawaii. However, it could have been triggered from Canaveral as well.

The Thor-Able reportedly had no gyroscopic guidance system but used a Douglas-built autopilot with Minneapolis-Honeywell gyroscopes. When the gyro started to drift, either the stabilization servo or the telemeter radio command link did not work. There probably would not have been a battery failure if "on the shelf" batteries capable of operating down to Arctic temperatures had been used.



PIONEER'S **THREE STAGES plus the instrumented payload tower 88.1 feet.**

Boeing Gets Prime *Minuteman* Contract

Boeing Airplane Co. has added the *Minuteman* ICBM to its growing list of missile development and production programs with the Air Force award of an assembly and testing contract. Contract amount was not disclosed.

The award was made to Boeing after the Air Force had evaluated approximately 18 bids from companies such as Douglas, NAA Missile Division, General Motors, Northrop and Lockheed. A company spokesman said the *Minuteman* test program will be the most demanding and critical of the entire weapon system. The three-stage solid propellant missile will be the most fully automatic long range system in existence.

Current concept will have the missile sites widely dispersed with the rockets in hard positions underground ready to go at the push of a button. The underground enclosures will hold the weapon at controlled temperature and humidity. Guidance system will be in constant readiness possibly with no prewarmup time required.

Boeing will center its *Minuteman* work at the main Seattle plant where the B-52 is now being produced. Phase-out in production of the B-52 sometime in February making available the high bay, large space areas for the assembly and testing of the missile in a vertical position, if necessary.

Lobber

System may be small *Project Adam* version

Army's *Project Adam* being researched by Army Ordnance Missile Command for its troop-cargo-carrying potentials is getting a healthy boost from industry.

Convair Division of General Dynamics Corp. has announced a smaller development—the *Lobber*, which could be *Adam's* short-range parallel project.

Project Adam originally was proposed to Advance Research Projects Agency by scientists at Army Ballistic Missile Agency as a means of getting man into space for a few minutes. Army had proposed rocketing an occupant to about 150 miles in a *Redstone* nose section which would have been parachute recoverable. The project was turned down by ARPA because it was felt its flight test would come about the same time as the X-15. Army, however, was authorized to research the project's potentials as a troop and cargo carrier.

The small Convair *Lobber* missile will be for short ranges, possibly under 25 miles. However, it can deliver rations, ammunition, medicines, communications equipment or other vital supplies accurately and in quantity to front-line troops, wherever and whenever needed, Convair said. The missile and its launcher can be hand-carried, if necessary, by a team of three men in the field.

Quick-disconnect *Lobber* payload sections can be pre-loaded at supply depots and at least 70% of every missile will be recoverable and can be re-used.

Maj. Gen. A. T. McNamara, quartermaster general of the Army, sparked development of the *Lobber*.

Lobber is also adaptable to offensive weaponry, carrying payloads of napalm, chemicals, high-explosives or small nuclear warheads, and has other uses in military engineering and communications.

Immediate capabilities of the *Lobber* are to provide emergency supplies for troops isolated by terrain or enemy action; monitoring radioactivity in contaminated areas; rapid buildup of supply depots under cover of darkness or weather; augmenting the mobility of beachhead assaults, and supporting purely offensive actions.

Most important in the Lobber concept, Convair said, "is utility when delivery is paramount; when bad weather prevents or restricts air drops, and when maximum mobility of a ground force must be maintained."

Wayward *Jupiter* Follows *Polaris*

For the second time in recent weeks a large ballistic missile has tempermentally gone astray within seconds of launch and had to be destroyed over the Cape Canaveral launching site.

An Army *Jupiter* IRBM was destructed directly above its launching pad creating alarm to the test personnel on the base. Personnel in the immediate area were well protected in the control bunker, but night crews working in other areas of the center were in danger of flying debris.

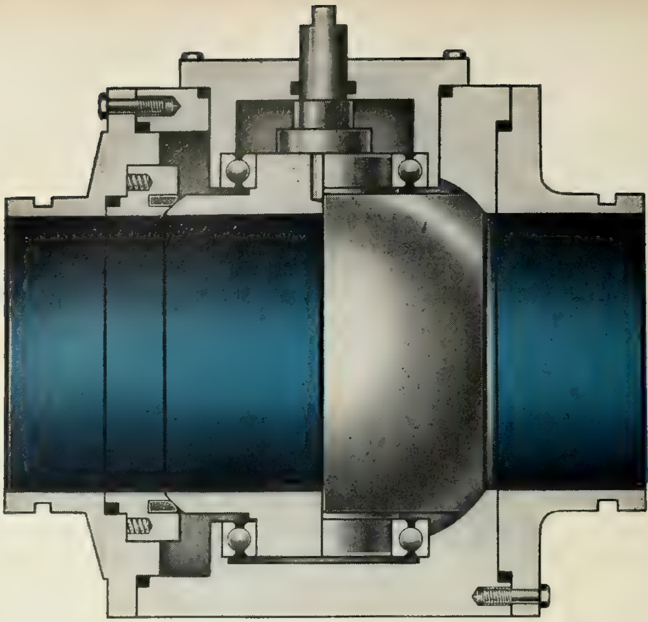
Two explosions rocked the missile before it fell to earth. At least one piece fell near the *Thor-Able* gantry where the second Air Force rocket vehicle was being prepared for its lunar probe shot.

Several days before the *Jupiter* firing a two-stage *Polaris* fleet ballistic missile forced Cape Canaveral personnel to take cover when it had to be destroyed shortly after take-off. Part of the missile went inland and impacted near a congested area of Cocoa Beach.

Hawk Readied for Deployment

U.S. Army

LOW LEVEL RAIDERS will be the target of Army's *Hawk* to be deployed in Washington area this year. Radar homing, the two stage missile with a range up to 22 miles will be the third member of the Army air defense missile team. Unlike *Nike Ajax* and *Nike-Hercules, Hawk* is highly mobile and can be transported on its mobile launcher, by aircraft or by helicopter. First emplacements probably will be in New York City and Washington, complementing present *Nike* installations.



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Zero leakage is assured through the use of a precision ball—the ideal geometric form for perfect sealing contact.

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Only FLO•BALL design, with its rotating valve action, permits side-by-side grouping of several valves, all driven simultaneously by a single actuator.

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HYDROMATICS, the world's leading designer and manufacturer of high performance ball valves for military and industrial applications, offers the most extensive selection of designs to meet all your requirements; Manual, motor or pressure operated. For cryogenic, corrosive or general service media. Pressures from vacuum to 10,000 psi. Sizes from ¼ inch to 12 inches.

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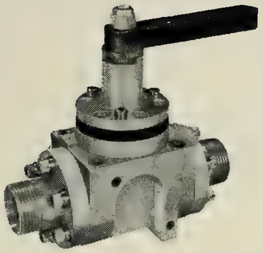

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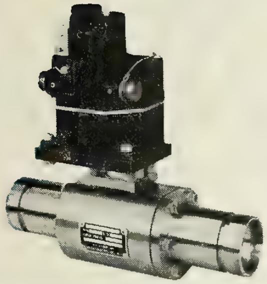

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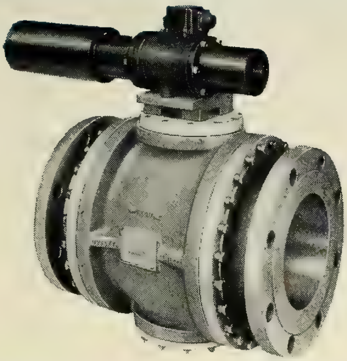

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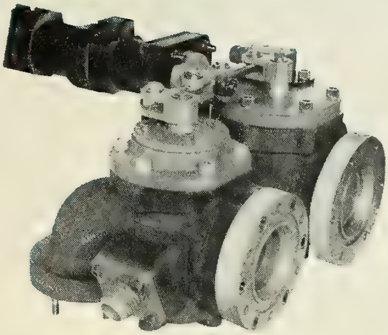

4.

1 MANUALLY OPERATED FLO•BALL CONTROL VALVES

Sizes from ¼ inch to 12 inches. Pressures from vacuum to 10,000 psi. Operating temperatures to —350 degrees F. Low torque operation; typical model requires only 5 pound force to operate at 10,000 psi. Fast, finger-flip action with 90-degree full travel. Positive open and closed indication with detent locks at extreme positions. Interchangeable flanges per AND10050, AND10056, Female NPT or ASA. Materials of construction include 2024 and 7075 Aluminum; Stainless Steel; Nylon, Teflon or Kel-F seals. These FLO•BALL manual valves are only one-quarter the size of any other type unit suitable for operation at comparable pressures and flow capacity.

2 PRESSURE OPERATED FLO•BALL CONTROL VALVES

For airborne and ground support applications where maximum flow and minimum valve size and weight are required. Sizes from ¼ inch to 12 inches. Pressures from vacuum to 10,000 psi. Interchangeable flanges. Sealed double-acting actuators, specially developed by Hydromatics to achieve maximum operating speed and efficiency. Full travel operating times as fast as 5 milliseconds. Actuator is thermally isolated from valve body to guarantee fast, positive action when operating at LOX temperatures. Open or closed valve position remotely indicated by a signal light, controlled by mechanical actuation of a sealed snap-type switch.

3. MOTOR OPERATED FLO•BALL CONTROL VALVES

Sizes from ¼ inch to 4 inches. Pressures from vacuum to 10,000 psi. Interchangeable flanges. Driven by D.C. motor actuators, these FLO•BALL valves provide an extremely smooth, fast acting response both on opening and closing. Motor actuator is thermally isolated from valve body. Full travel operating times from 0.5 to 20.0 seconds. Valve position is positively locked by a Geneva-Lock mechanism. Models available with remote light indication of valve position. Motor input voltage is 18 to 30 VDC. Automatic current shut-off is provided at the end of each operating cycle. Available with electrical connector, pigtails or pigtails with connector attached.

4. MULTI-LINE FLO•BALL PROPELLANT VALVES

Designed to handle LOX, JP-4 and all other missile and rocket fuels and oxidizers, these mechanically linked propellant valves are available in hundreds of line size combinations from ¼ inch to 6 inches. Pressures from vacuum to 10,000 psi. The precision linkage insures constant valve timing and reliable control. A positive-lock "lead" adjustment is available to vary the valving sequence between the lines. Special designs include 3-way or by-pass arrangements. Pressure-driven actuators may be specified to operate with gas or liquid at input pressures from 200 to 3,000 psi. Fast valve action, with full travel response times as short as 10 milliseconds.

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Ground Support Package for Guidance Control

Designed and built by Pesco, working in close cooperation with FARNSWORTH ELECTRONICS CO., a complete "check-out" package assures accurate pre-launch testing of BOMARC's guidance control system. The motor-generator features a Pesco Permanent Magnet Alternator—of 1.0 kva, 400 cycle power output at 3,000 rpm. The entire package including motor generator, magnetic amplifier type of voltage and frequency controls is contained in two sliding rack panels. Frequency regulation: ±2%; Voltage regulation: ±1% over a load range from 50-100%. Pesco creative engineering is offered, without obligation, to solve your Ground Support Equipment problems. Please contact:

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Arc-Furnace Gages Solid Life

In a program sponsored by Hughes Aircraft Co., Stanford Research Institute has developed several techniques for indicating when a solid propellant charge should be retired.

The project originally was aimed at solid propellants under consideration for Hughes' *Falcon* missile, and how they would stand up when exposed to extreme environmental conditions. However, the results may be applied to solid propellants in general. The information is being applied also to establish the basic causes of aging, and the end target is to reduce effects that cause solid propellants to lose their effectiveness.

One approach is a non-destructive involving ultrasonic principles to predict a propellant's remaining service life when it is installed in a "ready" missile or held as a replacement.

A ceramic plate is cemented to the charge and an electrical signal applied to the plate. This creates ultrasonic vibrations which are absorbed by the propellant. Any change in the degree of energy absorption reflects changes in propellant character, and an electrical measure of progressive change is obtained.

Another technique utilizes an arc-image furnace to measure ignition requirements and ignition behavior of solid propellants.

The arc-image furnace transmits radiant energy from a carbon arc through a reflecting mirror and shutter system that controls the amount of energy applied to a propellant specimen. Effects of propellant aging upon ignitibility can be determined by comparing the ignition energy requirements of fresh and laboratory-aged samples.

The effects of propellant aging are being observed by other methods—the measurement of burning rates and determination of physical properties such as tensile strength, shear strength and creep. The character and concentration of degradation products are being determined also by microscopic examination of propellant surface regions and various types of chemical analysis.

Lewis Lab Shuffles Top Scientific Personnel

CLEVELAND—Concurrent with the establishment of the National Aeronautics and Space Administration, Lewis Research Laboratory here has made organizational changes.

Eugene J. Manganiello was appointed associate director of the center, succeeding Dr. Abe Silverstein who has been appointed director, Space Flight Developments, NASA headquarters.

Dr. John C. Evvard and Bruce T. Lundin were appointed assistant directors. Dr. Walter T. Olson and I. Irving Pinkel were named special consultants to Center Director Edward R. Sharp.

Dr. Evvard will direct the activities of the Materials and Structures Division, Nuclear Reactor Division, Instrument and Computing Research Division (formerly the Physics Division), and a newly created Advanced Propulsion Division.

Lundin will direct the research conducted in the Fluid Systems Division, Propulsion Aerodynamics Division, Propulsion Chemistry Division and Propulsion Systems Division.

The Advanced Propulsion Division will be concerned with research into thermonuclear, ion, plasma, magnetohydrodynamics and other energy sources for propulsion of aerodynamic and space flight vehicles.

Main changes within the Instrument and Computing Research Division was the transfer out of aerodynamic noise research and incorporation of the work in the computing sections of the present Research Services Division.

Appointments within the research divisions are:

Advanced Propulsion Division, Wolfgang E. Moeckel, Chief; Instrument and Computing Research Division, Jesse H. Hall, Chief; Propulsion Aerodynamics Division, Carl F. Schueller, Chief; William A. Fleming, Assistant Chief; Propulsion Systems Division, David S. Gabriel, Chief.

No changes were made in the Fluid Systems, Materials and Structures, Nuclear Reactor, Research Reports, and Propulsion Chemistry Divisions.

Henry C. Barnett was appointed as Assistant to the Director.

Cold Matter Researched By U. of C. Electromagnet

Ultra-cold matter will be researched with the free world's most powerful, continuously operating electromagnet, just installed at the University of California. Studies at temperatures approaching absolute zero (−459°F) should aid in work with radar, missile guidance systems, and computers; also give exact information on non-available energy contained by various materials.

Chemists plan to use the newly-installed electromagnet to study matter in its degenerate state at the low temperatures. Recent findings over the past few years about the behavior of solid state materials at low temperatures have created a need for such facilities.

USED ON THE NEW BOEING B-52 JET BOMBER

New MS Miniature Plug

WITH SOLDERLESS SNAP-IN CONTACTS

Cuts Wiring Assembly Time as much as 80%

CANNON KM SERIES
FIRST TO MEET MIL-C-25955
(USAF) SPECIFICATIONS

THE PROBLEM—To design a miniature environmental-resistant connector, suitable for use on present and future aircraft, missiles and equipment, in accordance with military requirements. Dependability with simplicity to facilitate assembly, installation and field service were vitally important.

THE SOLUTION—Crimp-type solderless contacts, with wire insulation support, are used in the new KM. They can be easily snapped into place, or removed as necessary. Individual contacts can be serviced one at a time, without removing others. A specially designed moisture-sealing grommet replaces potting. Closed entry, machined socket contacts are probe-proof. All materials are of finest obtainable quality. Shells and related parts are of aluminum alloy, cadmium plated. Contacts are plated with gold over a heavy silver undercoat.

These features combine to provide a plug of optimum reliability that can be assembled and installed with utmost speed and be easily serviced in the field.

The new KM mates with the Cannon KO Plug Series, and is available in a wide variety of shell sizes, styles and insert layouts. Hermetically sealed receptacles also available. *For complete information write for Catalog KM-1.*

Come to Cannon for all plug needs—27,000 kinds to choose from. If we do not have what you want we'll make it for you. The largest facilities in the world for plug research, development and manufacturing are at your service. Write us today about your problem. Refer to Dept. 138

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STUHLINGER compares chemical and ion propulsion velocities.

WITH HIS CHILDREN, on a tour of Rocket City's Observatory.

Stuhlinger: Maybe Mars Before Moon

ABMA's research director thinks man may walk on Red Planet first; Ion propulsion may do trick

by Erica Cromley

If Dr. Ernst Stuhlinger's prophetic calculations are as accurate as his mathematical computations, you will open your newspaper one morning in 1978 to this headline: MAN LANDS ON MARS.

The director of the Army Ballistic Missile Agency's Research Projects Laboratory believes it is even possible that man will get to Mars before he tries the moon, because of our satellite's formidable 300° temperature spread and the problems involved in lunar landing.

The top research scientist on the Army's moon probe program and a top-runger on the famed von Braun team has already made inroads on the problems involved in ion propulsion—the ticket that will give man entrance to space travel. Mathematically investigated from all angles by Stuhlinger, the ion-propelled vehicle would use electrical power from solar or nuclear energy.

Despite his leaning toward a Martian-landing-first approach, Stuhlinger does not underestimate the importance of an American man-on-the-moon coup. Otherwise, his quip to a reporter in answer to how long it will take us to get to the moon may bear the germ of an unhappy truth. "Twelve hours," Stuhlinger said "One to get there and eleven to get through Russian customs."

Although such Stuhlinger witticisms are considered rare—"serious" is the word used most often to describe him—his close friends maintain he has a sharp and ready sense of humor.

Dr. Stuhlinger, at first appearance, is a mild-manner, excessively polite man. Closer inspection discloses a man who is a curious combination of scientific—almost pedantic—intensity and marked self-effacement. Praise of his work is met with noticeable embarrassment and protestation that any applause should be shared by the entire Redstone team.

"Our group is a big one and it works only because everyone works together," he said. "The success of the *Explorer* belongs to the von Braun team."

Wernher von Braun reveals that his research chief was upset when newsstories spotlighted Stuhlinger as the man who "pushed the button" for firing the second stage of *Explorer* I. "They have blown up my golden finger to make ill-conceived publicity," he told von Braun.

Nonetheless missile engineers feel the acclaim was justified. Although the space scientist had made advance theoretical calculations, Stuhlinger had exactly 3 2/3 minutes to recalculate at the time of flight on the basis of actual performance. As *Explorer* passed over San Francisco, Stuhlinger gave the signal and America's first man-made moon was on its way.

For all the publicity that comes to Stuhlinger via the *Explorer* and his work on ion propulsion, these areas are a minor part of the overall picture.

Says von Braun: "Stuhlinger's work covers the whole pie. Research in the field of plasma-flow—hydromagnetics, the cosmic radiation belt, and wave propagation. But his main job is to keep his eyes and ears open for progress in other fields that can be used in the missile field."

Stuhlinger has his own research budget and can select and let his own contracts. But like so many scientists who concentrate on pure research, he has to fight a continuous battle for funds. Governmental purse-string holders, never known for lavishness, are especially chary if they don't see the promise of a practical item.

• **Research problems**—Stuhlinger now has "a little money" for ion propulsion research. He lists the main problems as follows:

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EVEN AT VARYING ALTITUDE PRESSURES

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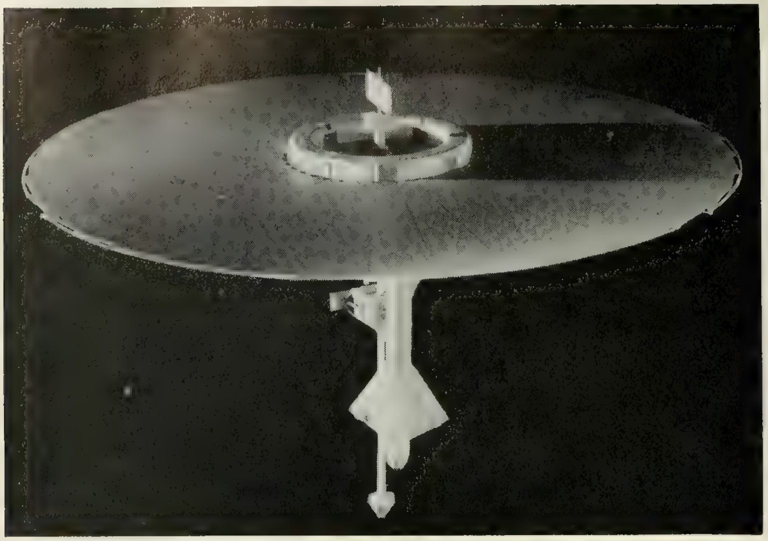

STUHLINGER CONCEPT of ion-propelled space vehicle.

(1) the ion source must give 90% to 95% ionization.

(2) the ion beam must be so formed and controlled that it won't hit electrodes.

(3) the beam must be neutralized after leaving the thrust chamber.

(4) lectrical energy must be produced.

(5) other ion sources should be investigated, particularly heavy molecules of atomic weight on the order of 200.

(6) design of the turbine must take into account lubrication, weightlessness, bearing sealing, high temperature operation.

(7) the electrical generator must be designed to present no cooling problem, no brush and commutator problems.

(8) the radiation cooler must be lightweight and not overly sensitive to meteors, perhaps segmented so that if one part gets punctured it can be cut out of the circuit while being repaired.

(9) guidance system must be perfected for interplanetary space.

(10) adequate crew compartment must be developed. Other problems to be faced include artificial gravity, feeding and communications in space.

When the Redstone scientist talks about his work and problems to be solved, he becomes an intense and persuasive salesman with a cause. The hesitant voice takes on a professorial, almost autocratic tone. When asked a question, he invariably starts out with: "The answer to that is the following: . . ." During the short space of the statement, his mind prepares the answer, which he gives in his rolling German accent while he draws out his pencil and illustrates with a diagram.

• **Background**—The two-toned Stuhlinger personality had its beginnings at Niederrimbach, Germany. He was born in 1913 in a family of teachers—they were his father, mother, two grandfathers and most of his uncles and aunts. His two sisters and two brothers-in-law also are in teaching. Young Ernst went along with the family tradition when, after receiving his doctorate in physics, he was appointed assistant professor of the Berlin Institute of Technology's physics department.

He was a faculty member from 1935 to 1941, working closely with Dr. Hans Geiger, developer of the Geiger counter. It was not until after a stint in the German Army that Stuhlinger entered rocket work, and met von Braun who was technical supervisor of the Rocket Development Center.

"When he was assigned to Peenemunde in the spring of 1944, he was still wearing his Army uniform," von Braun recalls. "He was a one project man in guidance and control and in no way a big wheel. It was quite awhile before we discovered we had a golden egg."

Stuhlinger's new assignment was a welcome challenge after surviving the battle of Stalingrad and a 600-mile hike through the Russian winter. A combination of a minor wound and the German Command's need for engineers brought him the V-2 assignment.

In 1946 he came to this country as one of the top ten of von Braun's 100 German V-2 sicentists. He firs ducted research and development worl with guided missiles at Ft. Bliss, an assisted in high-altitude research firing of captured V-2's at White Sands Proving Ground. In 1950 he went to Redstone Arsenal where he has become, i his boss's words, "a kind of vice president in charge of research." The vo Braun team has grown to 4,000 engineers, scientists and technicians.

• **Part of the team**—Stuhlinger, lik others of the von Braun team, ha been offered jobs by industry payin many times his present salary, but hi loyalty to von Braun and the tean won't permit him to consider thes offers. "I would rather work on th Huntsville team than any other" h said. "It has a record of real achievement in space activity."

One of the rare scientists able t bridge the gap between theoretica physics and practical research programs, Stuhlinger is a prolific contributor of papers at IAF meetings an technical journals, including the articl "Ion Propulsion and Why" which appeared in m/r in June of last year. H plans to publish a book on the subject

Stuhlinger says "Ion propulsio never will be practical for small interplanetary vehicles. I believe 50 tons i about the smallest size spacecraft whic would use it. Smaller than that yo would use chemical propulsion. I visualize a very large craft for a Mar expedition—several hundred tons."

The man who forsees a Martia landing in 20 years, and who will hav played an important role in its achievement, earnestly hopes we will put mor money into pure research before to long. "This is the way to scientific progress," says Stuhlinger. "Science shoul not have to ride piggy-back on th military."

Navy-Air Force Asking Bids For Rocket Target

The Navy and the Air Force wan a medium sized rocket or ramjet propelled target aircraft for missile firin fighter and interceptor aircraft.

A joint design competition amon manufacturers, seeking an air launched high altitude, expendable target with short flight duration has been announced by the two services.

Requests will be mailed late in October to manufacturers asking for detailed design proposals for competitiv evaluation.

In addition to rocket or ramje propulsion, air turbo rocket also ha been considered for the target vehicl which must be low in cost and higl in speed.

ANOTHER WAY TO LOOK AT IT

What the eye would see on the other side of the moon has intrigued and defied the imaginations of scientific minds for centuries. But there's another way to look at moon trips—from a very much down-to-earth point of view. The Space Age is built upon the ingenuity and capabilities of American scientists and engineers who have solved the myriad problems of the space arts—propulsion, stabilization, and control of launching vehicles—and the transmittal, reduction, and analysis of data so that man can comprehend the scientific import of his achievement. The Telecomputing Corporation, through the specialized activities of its six divisions, has contributed significantly to advancements in each of these areas of the space arts. Look to the skills, experience, and facilities of Telecomputing for the solution of your control and data processing problems. Write today for your copy of the TC story—"Blueprint For Progress."

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Circuit Development Group Leader Ralph Wolcott (left) considers future changes in computer output unit for bombing—navigational systems.

Ground-floor opportunities in

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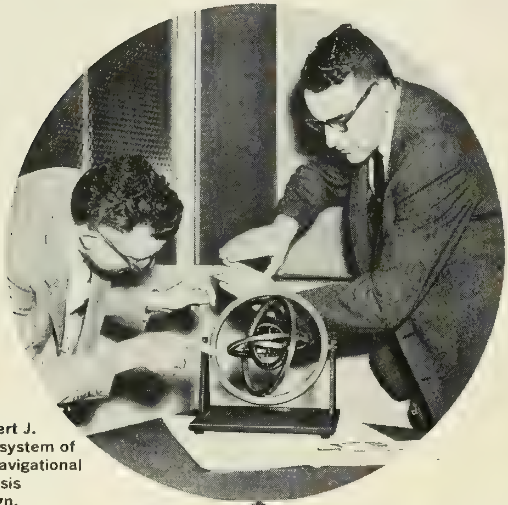

Project Engineer Robert J. Cantwell (left) uses a system of gimbals to describe navigational problems in the analysis of a new system design.

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Staff Engineer William Howard (center) reviews gearing accuracy requirements of test equipment with electronic circuit designers.

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Crosley Div. Readies For Avcomb Production

The Crosley Division, Avco Manufacturing Corp., Cincinnati, has announced development of a stainless steel honeycomb sandwich.

Called Avcomb, the lightweight paneling will be of value in missile and spacecraft applications, Crosley spokesmen said.

The material is said to have the strength of solid steel with but a tenth the weight. It reportedly will stand air friction heating up to 600 degrees F. without significant strength loss. This is about three times as much as aluminum, the company said.

Avcomb is in pre-production stage at Nashville, Tenn. Test and experimental quantities are being produced and studies are under way on mass production methods. The material has been produced in flat and curved panels. It was tested in late September.

NASA Appointee Hailed 'Fortunate' Choice

John A. Johnson, general counsel of the Air Force for six years, has been named chief counsel of the new National Aeronautics and Space Administration.

In making the announcement Administrator T. Keith Glennan, disclosed that Walter T. Bonney has been appointed public information officer. Bonney, who has been acting PIO, formerly headed the Public Information Office of the National Advisory Committee on Aeronautics which was absorbed by the new agency.

The appointment of Johnson was hailed as a "fortunate" one by Andrew G. Haley, president of the International Astronautical Federation who is known as the Dean of Space Law.

"A very thoughtful and prudent appointment," said Haley, "in view of his aeronautical and State Department experience. The two combined give him a basic 'feeling' for the law of outer space."

Johnson was with the State Department for two years (1946-1948) as assistant for International Security Affairs in the Office of United Nations Affairs. In that capacity he worked on international legal problems that involved the Security Council, Atomic Energy Commission, the Military Staff Committee of the United Nations and the United Nation's Commission for Conventional Armaments.

As head of the Air Force's legal department since 1952, Johnson has been aware of the problems involved in the development of international space law. He has had responsibility for several comprehensive studies of the subject made by the department. However, he feels this is strictly a long-range problem. "The law will follow man's activities," Johnson said, "it always has."

He thinks control of space will be a long time coming. Meanwhile he has suggested that all satellites be subject to international inspection prior to launching and that "certain types of information" obtained for space activities be made freely available.

The 43-year-old attorney, who holds degrees from De Pauw University, the University of Chicago and Harvard, joins NASA October 27th. Meanwhile, Paul G. Dembling, formerly NACA general counsel has been acting general counsel.

Missile Displays Set For AOA Annual Session

Missiles again will have the spotlight during the annual meeting of the Association of the U.S. Army in Washington, October 20-22.

Among exhibits will be a *Redstone* engine recovered from the sea after re-entry, an aluminum replica of the *Jupiter* nose cone, and the first exhibit of some new Signal Corps missile monitoring radar equipment.

Pointing up the missile theme will be a *Jupiter* C.

224 of Connecticut's manufacturers are producing missile parts or providing services to the missiles industry. An additional 272 have the ability and interest to perform missile work. This Directory lists missile parts and other products being made by these companies, and gives a numerical breakdown of personnel involved in manufacturing. It also lists research facilities. Here's a valuable guide for procurement officers and major missile manufacturers seeking skilled subcontractors. Write for your free copy to the Connecticut Development Commission at the address below. Or phone LeRoy Jones, Chief of Industrial Development, JAckson 7-6341, extension 548.

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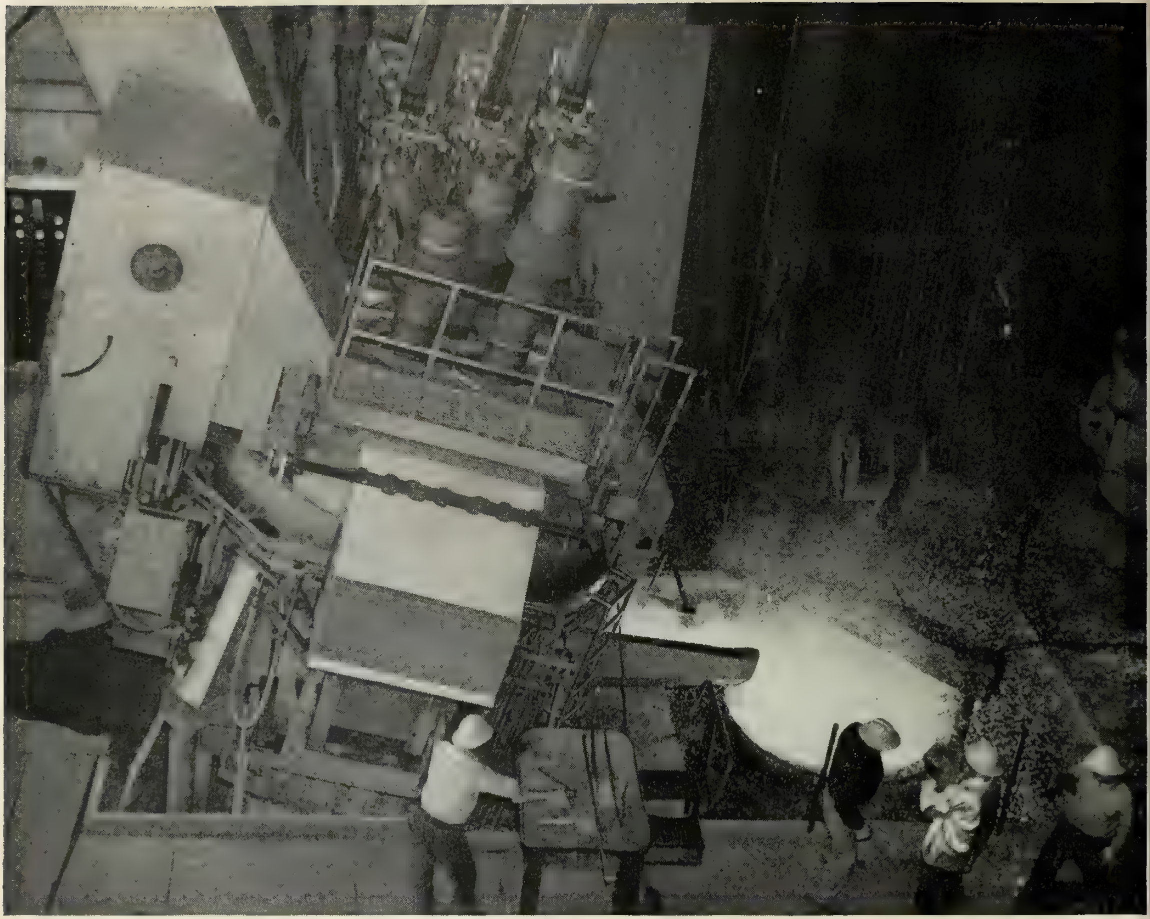

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Liquid Engines Lead Space Power Race

But with Russia leading in single-chamber work, improved propellants must evolve with engine development

by Alfred J. Zaehringer

Despite the gains being chalked up by solids during the past year (*Pershing, Polaris, Minuteman*) liquid propellant rockets are still far out front in the propellant race, both from the standpoint of performance and size. Though solids have put a big dent in terrestrial weapons, liquids are reacting vigorously by expanding out into space.

Even though the push toward raising specific impulse of liquids is still on, liquid engine manufacturers are not wanting in scale-up. The *Jupiter* IRBM engine is to be regarded as the first major step away from the old V-2 engine. The *Redstone* engine, which has attained a powerplant reliability of some 94%, can be regarded as the prototype for the *Jupiter* engine. *Jupiter*'s engine, with a nominal rating of about 165,000 pounds thrust, also serves on *Thor* and *Atlas*.

In the same manner, the German A-10 engine (rated at 441,000 lb) probably served as a model for the current Soviet T-2 engine. The T-2 engine, a single-chambered affair, is definitely rated above the 220,000 lb thrust class. More probably it is in the 250,000-270,000 lb thrust class—making it the world's largest existing single-chambered engine.

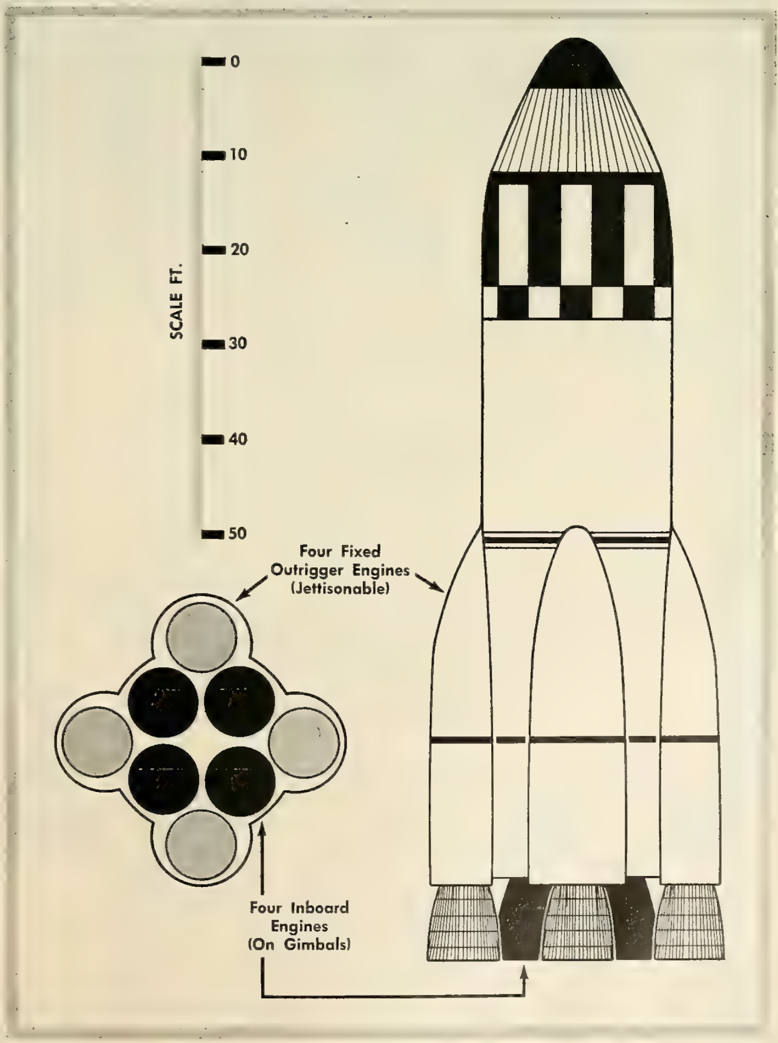
Whether the T-3 powerplant is single-chambered or is clustered is not known with any degree of surety. An accompanying table lists some of the liquid engines that show the evolutionary pattern mentioned.

• **Million-pound goal**—It is now becoming apparent that the Soviets have been working on a single-chambered rocket engine of at least one million pounds thrust for about 8-12 months. In another 4-6 months, this mammoth engine should be ready and should pave the way for more startling satellites and space missions. Even *Sputnik* III should then be small stuff and the US will again be shocked. The one meg Russian engine is already in the test stand.

By contrast, the million pound US engine is still some years off, estimates George Sutton of Rocketdyne, member of the single-chambered engine developers for the Air Force. Taking into account the lead time involved in the *Atlas* program and subtracting the learning process, the best guesstimate is that the megapound engine will not be ready for missile use before 1962.

• **1.5 Meg-cluster**—For this reason, this nation has placed a back-up program into effect for developing a clustered engine of at least one million pounds thrust. Roy Healy, Rocketdyne's *Jupiter* engine manager, figures that by clustering the proven *Jupiter*

How Jupiter May Be Clustered


SCALE FT.
0
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40
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Four Fixed Outrigger Engines (Jettisonable)
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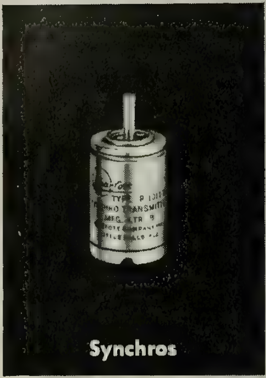
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engines, the million pound goal can
ready in about a year.

Eight *Jupiter* engines could be clu
tered to provide 1.3-1.5 megs of thrus
Possibly the inner four clusters wou
be on gimbals to provide stabilizatic
while four outriggers could be use
for boost and later jettisoned.

Much larger vehicles (and hen
payloads) can be boosted into spa
with these high thrust engines. Hov
ever, for more sophisticated space ve
tures, engines of at least 6-15 millic
pounds of thrust will be required. Thu
the eight engine *Jupiter* cluster wou
eventually have to bow out to the si
gle-chambered 1 meg engine. For ov
10 million pounds thrust, a 2-5 m
single-chambered engine will have
evolve.

• **Propellant prospects**—It will
much easier if propellants could al
evolve with the engines if serious spa
missions are to be considered. Use
fluorine-hydrazine could materially r
duce the size of the ICBM and t
moon impact rocket. Although LO
utilization will continue for some tim
new storable liquids appear destined
take over terrestrial liquid rock
weapons systems.

Fluorine rockets will probably
used for major space applications un
nuclear and ion rockets take over.
looks as if fluorine will be extensive
used for boosting space aggregate
providing, of course that solids do
manage to snag this field also.

• **LOX vs. storable**—The curre
feeling is that if you are going to ha
to work with a messy cold fluid li
LOX, then you might as well get me
sier and go to something with high
performance. Many difficulties asso
ated with LOX systems probably c
be attributed to the low temperatur
encountered in dealing with this flu
(−297 F). Pumps, seals, and valves a
especially critical items.

Therefore, storable liquids are b
ing seriously considered as the ne
step in improving the characteristics
liquids. Foremost among the LO
replacement candidates is nitrogen t
roxide. Available in tonnage quantitie
N_2O_4, is a high density (about 12 lb/g
at 77 F) liquid with a boiling point
about 70 F at atmospheric pressur
The vapor pressure is about 62 psig
140 F., which means that it can
stored without refrigeration.

One large producer, Allied Che
ical, reports that both Bell Aircraft a
Rocketdyne have done work with th
oxidizer. In addition, there have be

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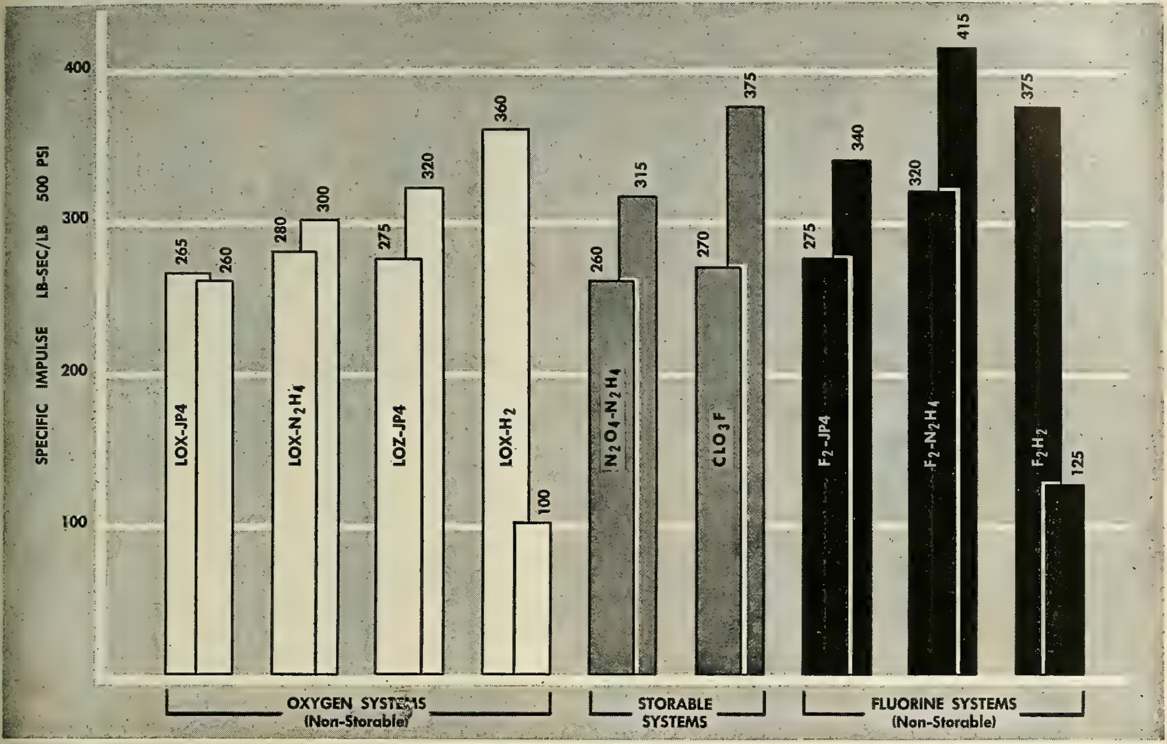

LOX-BASED systems are phasing out, storables will be used to bridge gap between LOX and fluorine. Small bar with each propellant combination on the chart gives the impulse times density ratings of the combination.

reports that Redstone Arsenal has taken a serious look at the tetroxide as a substitute for LOX. The oxygen content is about 70% by weight.

Performance is slightly under LOX but the higher density makes the difference. In a V-2 type vehicle, the use of N_2O_4 will give a 12% increase in range because of the higher density. The oxidant is hypergolic with such fuels as hydrazine, cyclic hydrazines, aniline, toluidine, and xylidine with furfuryl alcohol, cyclopentadiene, pyrocatechol, and metal carbonyls. Another advantage is the fact that it is non-corrosive to ordinary carbon steel under anhydrous conditions.

Another bright prospect for a storable liquid is perchloryl fluoride (PF), ClO_3F. Pennsalt has rushed this oxidant out in time to hit the increasing storable liquid interest. Performance is slightly greater than for nitrogen tetroxide, though it has a better impulse-density rating. PF melts at –231 F and boils at 53 F. Vapor pressure at 71 F is 176 psia. PF also is non-corrosive when anhydrous. Density of liquid PF is about 1.4 g/cc.

• **Ozone out**—The application of liquid ozone to rocket propulsion is practically dead. Of considerable interest is the fact that Clark Thorp, one of the nation's outstanding ozone exponents, has left Armour Research Foundation. ARF was one of the last strongholds in advocating use of liquid ozone for an oxidant.

On the other hand, it appears that the Russians have not given up on ozone and, in fact, may have already applied it for liquid rockets. It may be that the Soviets are using liquid ozone in combination with LOX to give immediate propulsion gains.

• **Monopropellants uncertain**—Despite the wild claims about liquid monopropellants, the fact remains that only a handful of US groups are actively working on liquid monopropellants. These are: NARTS, Phillips Petroleum, Stauffer Chemical and Wyandotte Chemicals.

Performance over 250 I_{sp} apparently is not too hard to achieve; the big stumbling block is sensitivity. Aside from low performance auxiliary power systems, no liquid monopropellants are operational—nor are they likely to be for at least 5 years—and then only in small engines.

• **Fluorine in lead**—The most likely

Leading Liquid Rocket Engines

Engine	Sea Level Thrust (lb.)	Engine length (ft.)	Engine diameter (ft.)	Exit Nozzle diameter (ft.)	Notes
Viking	20,000	2.85	1.6	1.6	RMI
Vanguard	27,000	3.2			X-405 by GE
V-2	56,000	5.67	3.1	2.4	German, LOX-alc.
Jupiter-C	~79,000				Hydyne fuel-LOX Rocketdyne.
Jupiter	~165,000	7.0	2.5	4.0	LOX-RP Rocketdyne.
Saenger	220,000				German, LOX-oil.
T-2	> 250,000	11.0	5.0	5.5	Soviet IRBM.
A-10	~441,000	12.0	6.0	6.0	German, LOX-oil.
T-3	> 500,000				Soviet ICBM.
	1,000,000	17	7	8	Rocketdyne.

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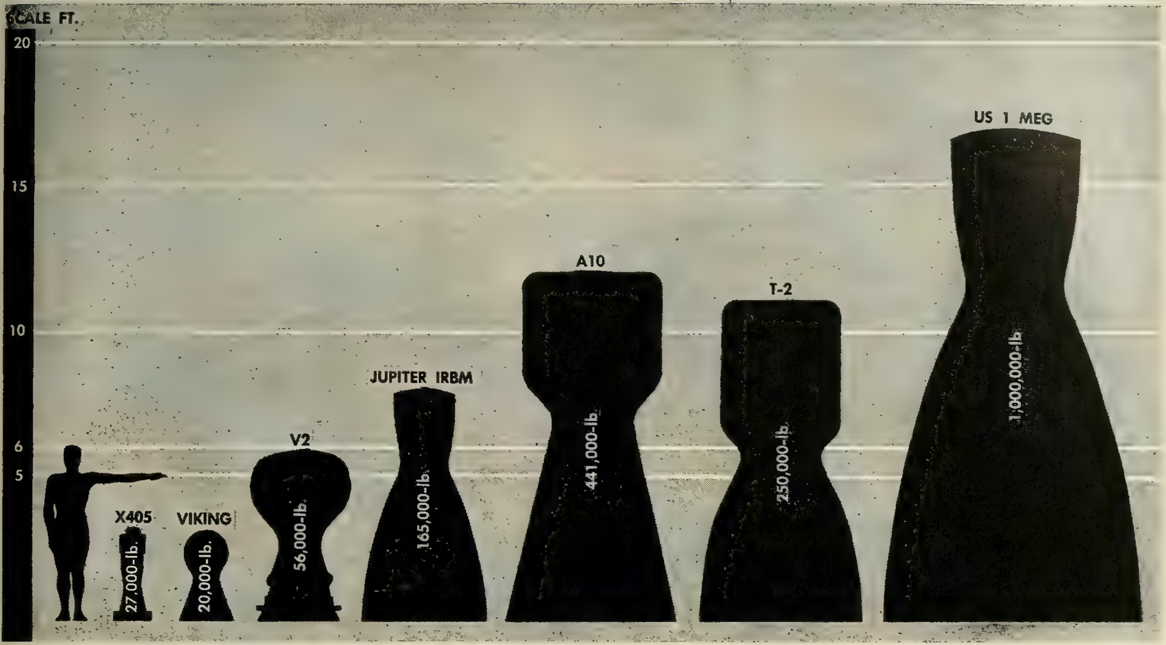


EVOLUTION of liquid rocket engines. Drawn to scale, growth from 27,000 lb. thrust *Vanguard* engine (at left) to 1 million lb. thrust Rocketdyne model. Soviet T-2 engine is about twice as powerful as *Jupiter* engine.

chemical contender to succeed in liquid rockets will probably be liquid fluorine. Despite messy handling, toxicity problems, and high cost, fluorine figures big in future space applications.

Both Rocketdyne and Bell Aircraft have fired medium thrust fluorine rockets, while NACA has put in several years of work on fluorine systems. With NACA forming the nucleus of NASA, it is expected there will be a pitch for large fluorine rockets.

Fluorine is probably the last chemical plateau that rocket engineers can look to. It shouldn't be too difficult to get an I_{sp} of at least 300 seconds immediately. Large fluorine rocket engines is not too far off. The Air Force rocket engine test stand at Edwards is getting ready to handle a liquid fluorine engine (probably a modified *Jupiter* IRBM) of about 170,000 pounds thrust for a duration of up to one minute.

Fluorine has been trucked around the country for some time, but supplying this material on overseas bases may be another matter. For this reason, it looks like anhydrous HF will be shipped to remote bases where it can be electrolyzed to form elemental fluorine.

- **Fuel fiasco**—For a long time there had been a mistaken belief that fuels were the thing to look for in radical rocket performance increases. It has been found that, with a given oxidizer, the range in specific impulse from the hydrocarbons to the exotics to hydrogen lies in a quite narrow band. For this reason, other factors such as cost and handling are often more compeling deciding parameters.

Currently, the swing has been from the alcohols to petroleum hydrocarbons. The next step will be toward hydrazine base stocks. Whether the boron exotics will move into the rocket engine field is debatable. Boron hydrides are having a hard enough time proving themselves in turbojets and ramjets, let alone in rockets. One of the big stumbling blocks is the high combustion temperature which, in large rockets, means short durations or cooling.

The thermal stability of boron exotics will probably preclude them from use in regeneratively-cooled engines. For this reason, boron may make a bigger dent in the solid rocket picture than in the liquid field.

MIT'S Weber Named Advisor in Army R&D

Dr. Harold C. Weber of the Massachusetts Institute of Technology and member of the Army Scientific Advisory Panel, has been appointed Chief Scientific Advisor Consultant to the Army's Chief of Research and Development.

Professor of chemical engineering at MIT since 1921, Dr. Weber is the author of numerous technical articles and the textbook "Thermo-dynamics for Chemical Engineers." He was also a contributor to "Marks' Mechanical Engineers' Handbook."

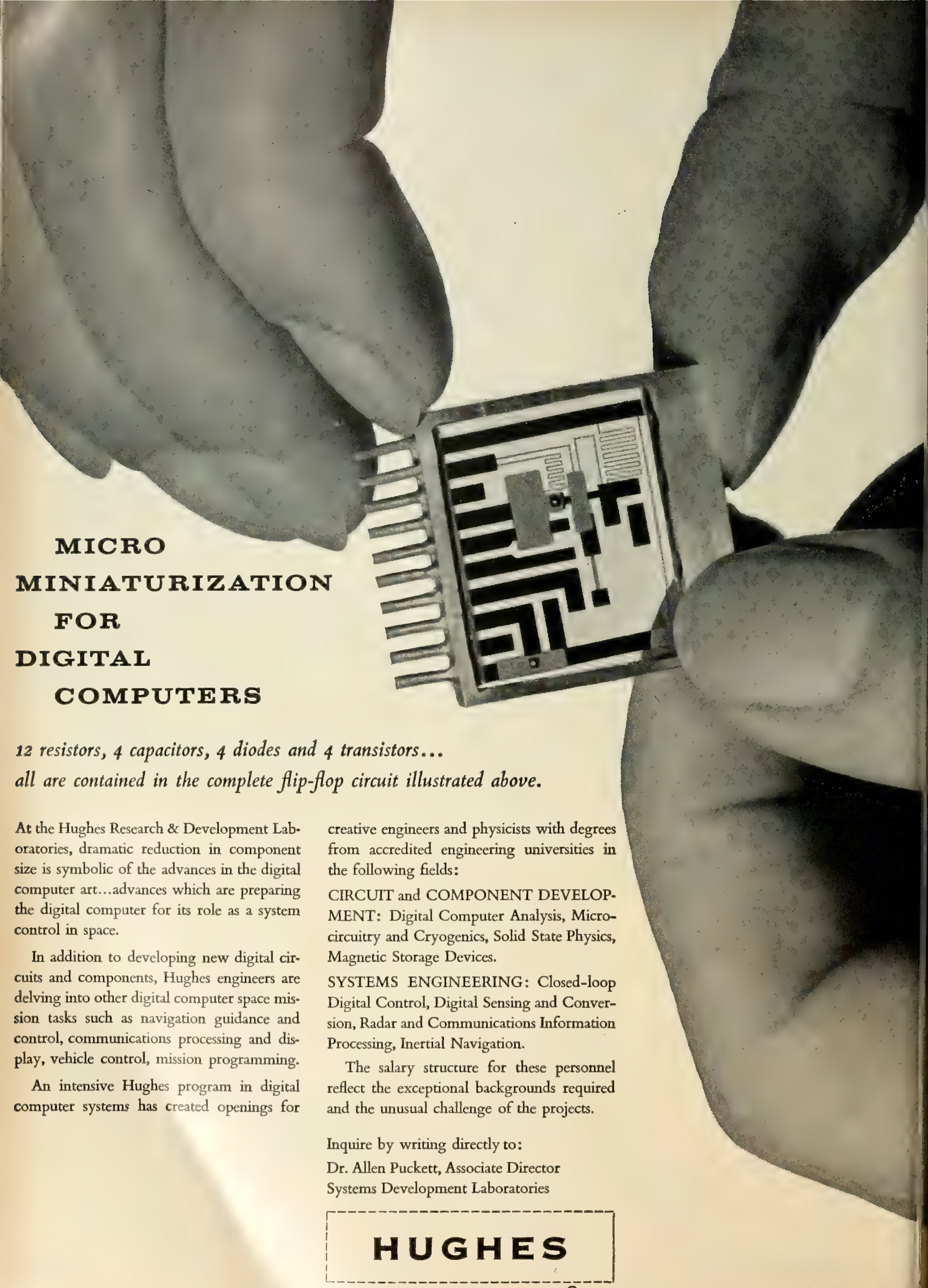
The new scientific advisor received his BS from MIT in 1918 and his doctorate in science from the Eidgennoische Technische Hochschule in Zurich, Switzerland.

French Army, Air Arms To Split Missile Work

French Minister of Defence Guillaumat has ordered what official communiques called a "specialization of the efforts" of the Army and Air departments in the fields of missiles, it was recently announced.

Under the order, the Department of Ground Forces will concentrate its efforts on development of all types of ground-to-air missiles. The Department of Air will concentrate on the development of ground-to-ground, and air-to-ground—as well as air-to-air weapons. These latter will include the short-range SS 10/11/12 anti-tank missiles.

The order, however, specifically does not forbid the Army to work with aircraft manufacturers in future missile development.



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Inquire by writing directly to:
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Tooling for Space Age Feature of L.A. Show

The challenge of space age tooling requirements highlighted the technical sessions held in connection with the first biennial Western Tool Show in Los Angeles under the sponsorship of the American Society of Tooling Engineers.

With 250 exhibitors displaying more than $5 million worth of products ranging from automation to assembly and fastening devices, theme of the five-day event was "Tooling for the Space Age."

Precision, in the future, will be measured in millionths rather than tenths of thousands. "And when we stop to reflect that such tolerances encroach upon the measurement perimeters of our own Bureau of Standards one must certainly ask 'where do we go from here?' " observed A. S. Turner, assistant chief tool engineer for the Northrop division of Northrop Aircraft.

The job of tooling the *Snark* missile was found in the inner components rather than in the outer structure, Turner reported in a paper on the Air Force's first intercontinental missile. Fine tolerances that defy conventional tooling techniques are the rule rather than the exception in the guidance section of the *Snark*. He told how equipment to generate gear teeth of 5.0 secs. of arc from tooth to tooth, noncumulative over 54 teeth, was developed.

The use of optical measurement will increase to the point of becoming routine practice in missile tooling, Turner said.

L. G. Granstedt, chief tool engineer for Convair-Astronautics, also emphasized the use of optical tooling in obtaining the alignment of the component pieces that go into the assembly of a missile, such as the *Atlas*. From the *Atlas*, Convair learned that tool designers must get into the field of special mechanized tools and the jig and fixture man must become, to a degree, a machine tool builder.

"Automatic controls on tools are not a thing of the future, but, as on the *Atlas*, are an established fact of the present," Grandstedt declared. The broadening field of tool engineering is encompassing previously unrelated fields of machine design and electronics, he added.

In this age of phenominal engineering developments, manufacturing must be as visionary as engineering, said T. F. Vajda, supervisor of tooling and manufacturing methods at Plant B-9 of Lockheed's Missile Systems division. He declared that tooling, methods and ingenuity become synoymous.

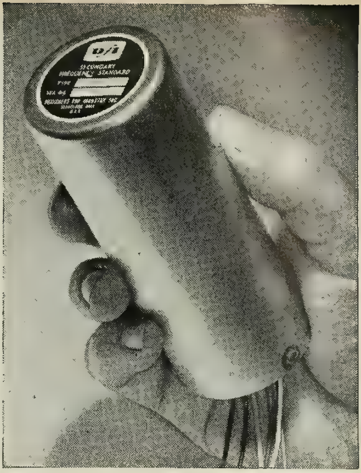
Nike Hydraulic Test Stands Awarded Hufford

Nike missile system hydraulic test stands will be provided by the Hufford Division of the Siegler Corp. under a contract in excess of $350,000 awarded by Douglas Aircraft Co., according to Dan W. Burns, Hufford president.

Under the terms of the contract, the second of its type to be received, Burns said, Hufford will provide an undisclosed number of test units to be used in *Nike* sites for periodic functional tests of hydraulic components in the ground-to-air missile's launching equipment. Test stands of this nature are required, he said, to make certain all segments of the launching equipment's hydraulic system are operational following a protracted period of setting in the ready position.

Newest for Navy Missiles

GUIDED MISSILE FRIGATE will be built by Bethlehem Steel, at Quincy, Mass., which recently received a letter contract for design and construction for $10 million, with fixed price contract to come. Scheduled for delivery in January, 1962, the ship —designated DLG(N)—will have twin *Terrier* missiles fore and aft, plus conventional armament. Bethlehem already has contracts for the first nuclear-powered guided missile cruiser, the "Long Beach," and installation of *Terrier* handling and guidance systems for three conventionally-powered guided missile frigates.



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The close interrelationship of these two major projects, the widely diversified specialties involved in them, and the dominating influence of man-machine relationships make SDC's work unique. Operations Research Specialists, Engineers, Computer Programmers, Behavioral Scientists—all find their assignments reflect the unique qualities of this new field.

The expanding scope of SDC's work has created a number of positions in these fields. Inquiries are invited. Address: R. W. Frost, 2414 Colorado Ave., Santa Monica, California, or phone collect at EXbrook 3-9411 in Santa Monica.

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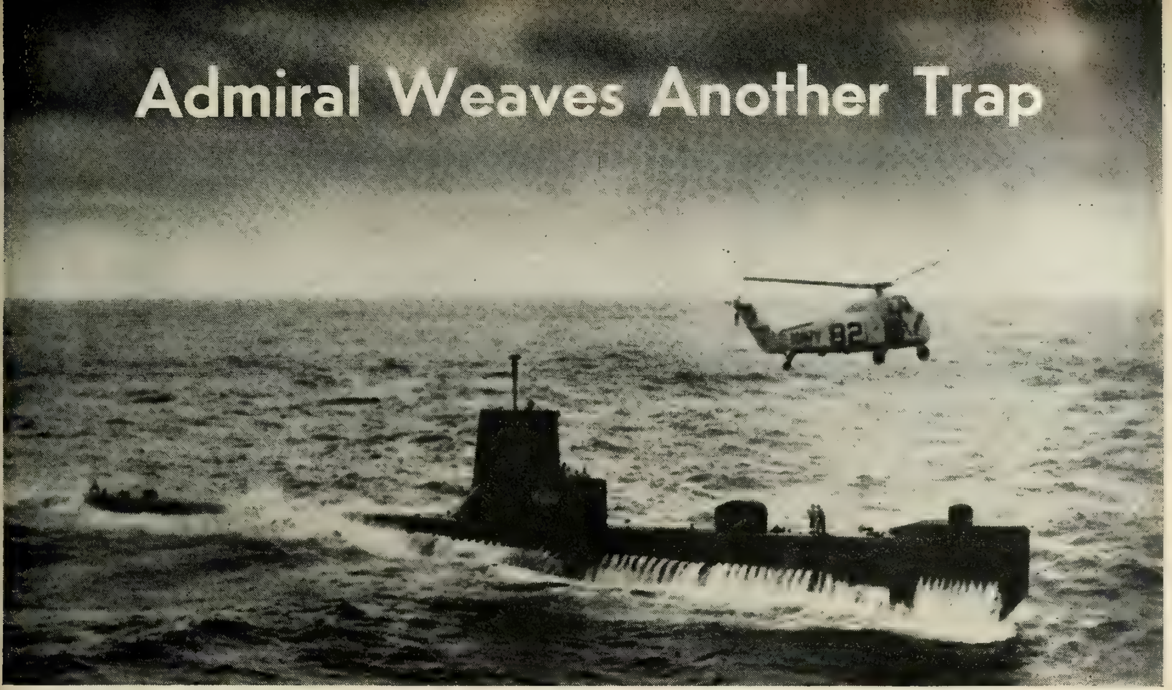
Admiral Weaves Another Trap



Problems of "Liquid space" offer challenge to industry—help needed to meet submarine missile threat, Thach says

by William O. Miller

Task Group Alfa consists of an aircraft carrier—the "Valley Forge"—its air group of fixed wing anti-submarine aircraft, a helicopter squadron, destroyers, shore based patrol aircraft, lighter-than-air patrol craft, and submarines. It is the sea-going "laboratory" for the Navy's Anti-Submarine Defense Force, which was formed July 1957 to meet the growing threat of defending this country against enemy submarines.

The man saddled with a large part of the responsibility of facing up to this defense challenge—Rear Admiral John S. Thach, commander of the Navy's special Task Group Alfa—looks it squarely in the eye, and says:

"The submarine-launched missile is the greatest single threat facing this nation today. None of us have any illusions about the problem, but one thing we know for sure—it's got to be met and solved. It's our job to see just how good we are with what we have."

During World War II, the same Thach helped solve the problem of fighting faster, more maneuverable Japanese Zeros—these new fighter tactics became famous as the "Thach weave."

Task Force Alfa operates around the clock with one exercise following another, improving old tactics, experimenting with new approaches (both from the viewpoint of the sub-hunting units and the target submarines), trying out new equipment when asked, and welding men into an integrated team.

However, there is one thing—and it is a key point—that the Task Group Men don't agree on: the sub hunters are pretty sure they can take on any sub, and the submarine crews are equally convinced that they have the edge.

All-hands job—In response to personal orders of the Chief of Naval Operations, Admiral Arleigh Burke, the force was set up last Spring and is being given the latest and best the Navy has in the way of ships, personnel, equipment and weapons. A unique feature of Task Group Alfa is that for the first time, the Navy is assigning units to an anti-submarine force on a semi-permanent basis. But there is still much to be desired. Admiral Thach explains it this way:

"The research and development of adequate weapons and search and identification equipment is an all-hands evolution. The Navy has not ignored the anti-submarine problem in the years since World War II, but it has been difficult to generate nationwide interest in such an unglamorous program. Consequently, effort and money have been concentrated in other areas. What we need are some major break-throughs to meet the threat we were made aware of by our own development of Fleet Ballistic Missile System.

"These break-throughs cannot be made overnight. Discovery of new principles results from years of research and concentrated effort. We cannot expect results without it. It's never been so when we have had to meet other challenges, and we'd be kidding ourselves if we thought differently now. We need help and need it badly, from every segment of industry concerned with the tools we need, and from many people who probably aren't even aware they might be able to help us."

Admiral Thach points out that the preoccupation of the nation and the military with the problems of space, earth satellites, missiles, and counter measures can be turned to an advantage.

"All across the country thousands of people in industry and privately operated laboratories are working on the problem of space. I am sure that they will make discoveries, and bring to light new principles which could assist in the break-through we need in solving anti-submarine problems—if they are aware of the problem."

Liquid space—Admiral Thach likes to refer to the sea's vast subsurface ex-

THREE ELEMENTS of sub-killing team—helicopter, seaplane and destroyer—are ready for their jobs.

DESTROYER FINISHES "kill" with depth-charge, after aircraft have marked location of target.

panses as "liquid space." He points out that the major difference is the density of the element, a lack of knowledge concerning the nature and topography of the ocean bottom, and detailed information in many areas.

"You might call us sea-going psychiatrists," Admiral Thach continues, "We know our subject quite well from surface observations. We know many of its moods and physical features. But as we probe further into the depths, we encounter many phenomena and observe many things for which we can offer no explanation."

All these phenomena, Thach says, are interesting and often very strange. And some are nothing less than disturbing. For example:

"The concealment offered by the ocean depths provides the biggest launching pad in the world to any enemy intent upon destroying this country. The disturbing thing is that this launching pad is free to be used by anyone with the knowledge to use it. It extends right to our front door from Maine to Texas, and from Canada to Mexico."

Ocean research lags—Earthmen actually know more about the surface of the moon than is known about the bottom of the oceans—a large proportion of the earth's surface.

"The Russians probably will make available more IGY information of an oceanographic nature than they will concerning their satellite and space programs," Thach commented.

Oceanography as a science is relatively new. It actually began with the round-the-world cruise of the HMS Challenger from 1872 to 1876. There had been other similar voyages before, such as the "Beagle" with Charles Darwin; but none gathered the vast new scientific information that the "Challenger" accomplished in its three and a half years and 69,000 mile exploration in the Pacific and Atlantic.

In oceanographic research ships, the United States lags behind several nations. Foremost among them is the Soviet Union. The largest U.S. ships are the 2,700 ton "San Pablo" and the "Rehoboth" of the Hydrographic Office, but the majority are of the 500 ton class or less.

The Japanese have been active because of the importance of the fishing industry to that nation. Great Britain has a number of modern units. The Russians have several in the 5,000 ton range and two 12,000 ton ice breakers, which are classified as oceanographic research ships. This may or may not have some bearing on the fact that the first announced use of nuclear power for ship propulsion by the Russians will be for an ice breaker.

It is not only on numbers and size that the U.S. lags, but in the design and facilities on the ships. The 298-ton ketch "Atlantic" is the only American vessel originally designed for research purposes, while the Russians are building specially-designed vessels which have a number of laboratories and up to 60 scientists aboard. Of special interest is the first cruise in the North Atlantic, completed late in 1957, by the Russian 5,960-ton "Mikhail Lomonosov."

The most optimistic estimates of the situation are that the U.S. has about 10 years to catch up and carry out a 25-year replacement program.

Why needed—A better knowledge of the element is a prime requisite for efficient undersea warfare. The sea is a strange and noisy place. All sorts of marine life make noises that either sound like ship noises or contribute to the general sonar confusion so as to cover up the noises of another ship or a submarine. The ocean bottom, for the most part, is an unexplored jungle.

The vast undersea rivers and currents which conceivably could be used by submarines, just as aircraft use jetstreams, are not completely located. The differences in temperatures of layers of water which bend and distort sound waves and provide a protective cover for submarines must be penetrated. And there are always those strange phenomena for which there is no explanation. The decoys are many and varied.

Greatest need—"Our greatest need," Admiral Thach says, "is for longer range detection equipment and the weapons to give us the kill capability by the time we have the extended range search and identification gear."

Sonar is still the basic means of searching the depths. There is limited capability in determining what the target is. The range of weapons, other than the nuclear depth charges and warhead, has gone little beyond World War II. To sum up, what is needed:

Improved detection, classification and kill ability.

Weapons presently on hand include the fixed wing aircraft and helicopters of the aircraft carrier. The Grumman S2F Trackers can employ a variety of weapons including the Mark 43 homing torpedoes, depth charges of both the conventional and nuclear type, and Mark 5 rockets which are effective only against a submarine on or very near the surface. Important in its search equipment is the magnetic aerial detection gear (MAD), which though limited in range, can differentiate between metallic and non-metallic contacts.

The destroyers of the task group have in addition to World War II type depth charges and the Hedgehog, Weapon Able and the Rocket Assisted Torpedo (RAT) which have limited range and other shortcomings.

The submarine major weapons are the old model Mark 14 torpedo, the smaller and slower acoustical Mark 27 and 28, the homing torpedo, and the now-available wire-guided torpedo.

The 16 helicopters on board the Valley are Sikorsky HSS-1, which employs the dunking sonar to detect and hold a contact until the killer sub, surface vessels or aircraft can arrive on the scene to assist. The HSS-1's can employ the Mark 43 torpedo and depth charges, either conventional or nuclear. Greater endurance and greater life capability is needed here. Thach said that one shortcoming, a night capability, will be met with the delivery of HSS-1N's due in about a month.

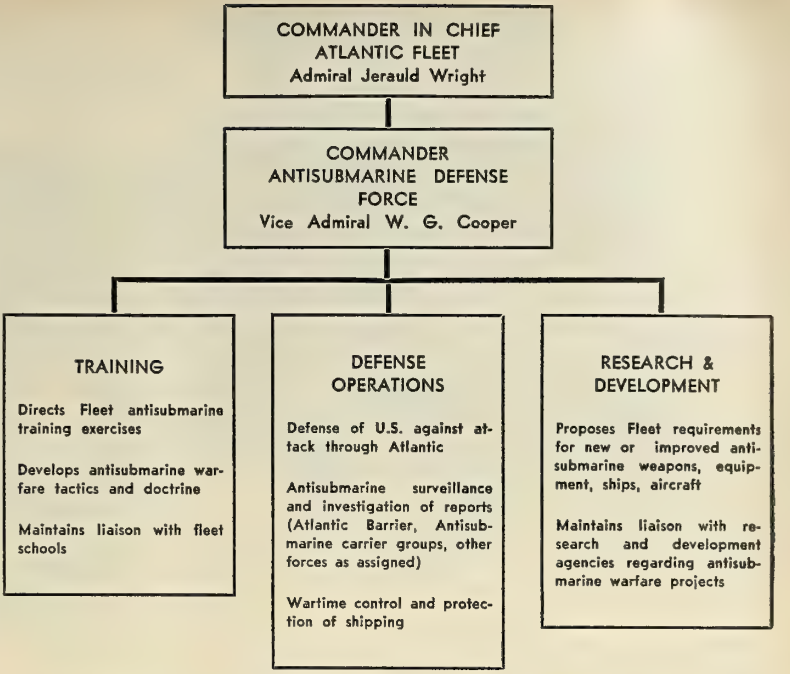
Other areas in which there is need for improvement are synthetic trainers to instruct personnel in the most effective use of varied and complex equipment, easier maintenance of the electronics equipment, automatic navigation equipment for aircraft, and an automatic means of plotting the tactical situation so that the units may be directed to make the most effective attack upon the target.

Subs on team—Probably the greatest innovation developed by TG Alfa is the utilization of the killer submarine as a part of the hunter-killer team. The submarine is particularly valuable because of its ability to drop sonar detection gear lower than the helicopter. The information thus obtained can be sent to attacking aircraft and ships. Surface noises can be minimized, and the submarine can get below the gradient that ships and helicopters can't penetrate.

Despite advances of four to five times the effectiveness of World War II sonar, stepped-up investigations of the complete sound ranges from very low to the very high frequencies are badly needed.

Communications is a special problem for the submerged submarine. The sub can talk by underwater telephone to surface ships, but the range is extremely short.

The submarines vitally need a breakthrough which will give them a weapons system to match those in other vessels. Present weapons are not up to detection ability. Control of highspeed underwater vehicles such as torpedoes are a special problem inasmuch as even limited use of control surfaces can cause wildly erratic movement of the torpedo. A number of possibilities are under consideration, including chemical torpedoes or even rocket propelled torpedoes to provide high speeds and better control.



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Admiral Jerauld Wright

COMMANDER
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Vice Admiral W. G. Cooper

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Develops antisubmarine warfare tactics and doctrine

Maintains liaison with fleet schools

DEFENSE
OPERATIONS

Defense of U.S. against attack through Atlantic

Antisubmarine surveillance and investigation of reports (Atlantic Barrier, Antisubmarine carrier groups, other forces as assigned)

Wartime control and protection of shipping

RESEARCH &
DEVELOPMENT

Proposes Fleet requirements for new or improved antisubmarine weapons, equipment, ships, aircraft

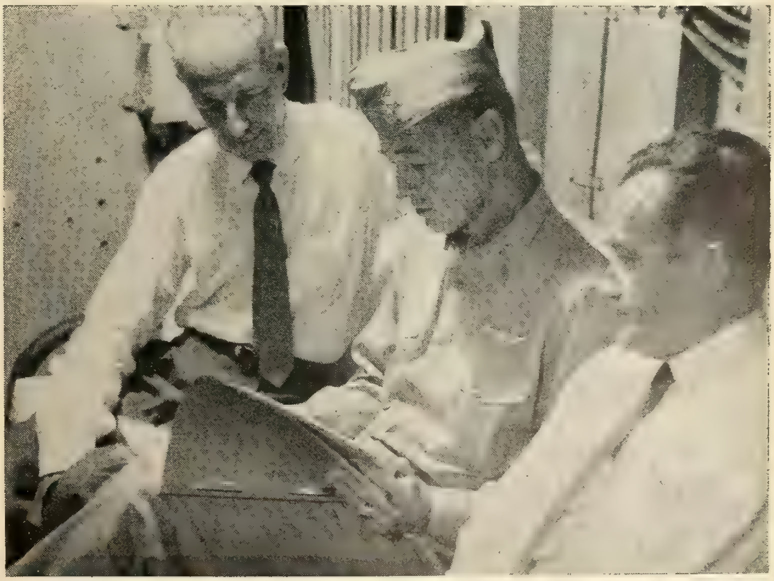
Maintains liaison with research and development agencies regarding antisubmarine warfare projects

ORGANIZATION of Navy's efforts to combat undersea attack is clear from chart.

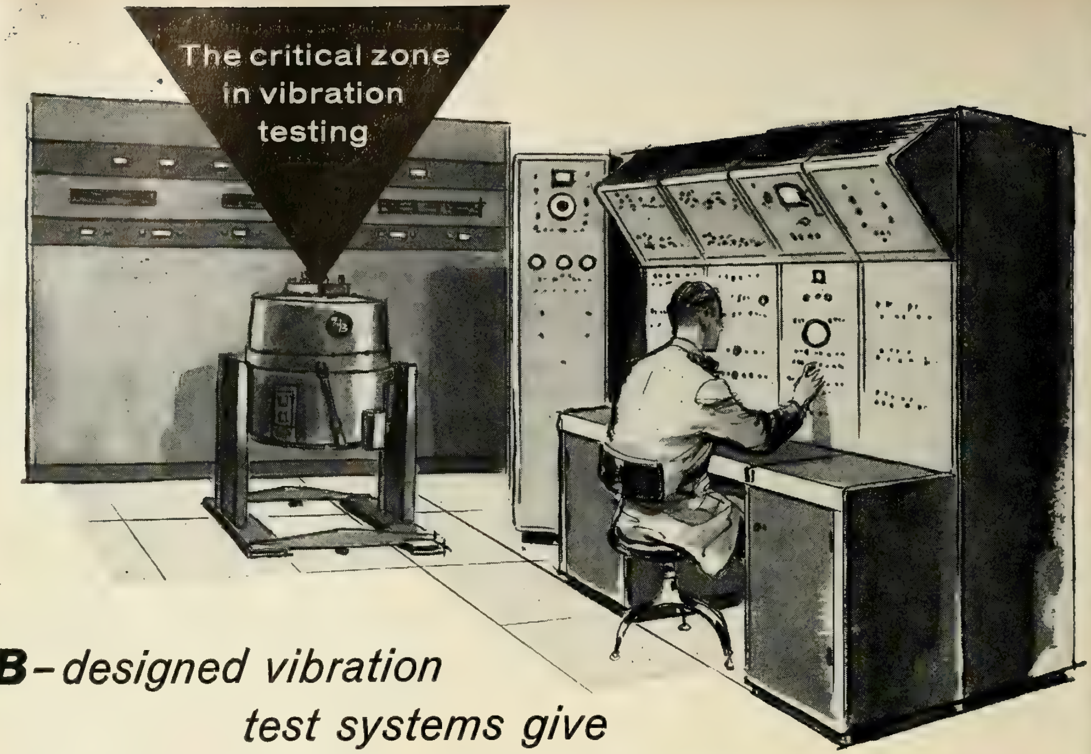
Part of the Force—Task Group Alfa is only a part of the Anti-submarine Defense Force commanded by Vice Admiral W. G. Cooper. It is part of the training operations, but in time of emergency, TG Alfa would join the other anti-submarine carrier groups in the defense forces. Adm. Cooper has four such hunter-killer groups under his operational control, as well as other ASW forces. He is responsible for all phases of anti-submarine defense, including resarch and development.

The heart of the system is the operations control center at Norfolk, where all reports from aircraft flying the Atlantic Barrier from Newfoundland to the Azores, merchant ships' reports, or contacts from any source are plotted, evaluated, and if necessary, investigated.

In some ways, the peacetime job is



ADM. THACH considers held of industry men essential to his task.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more difficult than a wartime task. It's not as simple as making contact, evaluating it as an enemy and proceeding to attempt a kill. Under international law and in peacetime, a capability of prolonged surveillance is necessary, which points up the necessity for major breakthroughs in detection and classification methods.

As Admiral Thach says, "The problem is new; therefore, the defense must be new—and when we have to cope with nuclear submarines, our job will be more difficult than it is now—detection by present-day conventional means will be much more difficult, for instance."

There seems little doubt that some of the current reports of unidentified submarine contacts are genuine. In all probability, they are probes and tests of our defenses and our ability to detect such probes.

"We've got to be able to detect and identify," Thach says, "or else our potential enemies can use their submarine forces to blackmail our weaker allies by pointing to our inability in this area."

Observers—The cabin door is wide open in Task Group Alfa. Since its formation, there has been a continuous stream of some 60 guests from all segments of industry. They have witnessed the operations, seen what the problems are, and are better able to appreciate the task which must be carried out by the naval force.

From such visits as this, Admiral Thach hopes to stimulate an interest in his Task Group. Although his Task Group cannot be an equipment research and development organization, he said he is willing to try out anything offered to fill the present gaps in communications, weapons, detection and identification gear. However, he points out that actual cognizance for such equipment comes under the appropriate bureau, and proposals concerning them should be sent to the proper naval bureau first.

As his Task Group busies itself in its 10,000 square mile training area, always ready to move in any direction to investigate unidentified contacts, Thach considers the 12 million square miles of water that forms the North Atlantic and says:

"Everybody is busy looking at satellites. We're like the man worried about the chandelier falling on his head, who then gets the rug pulled out from under him—we need help in nailing down the rug."

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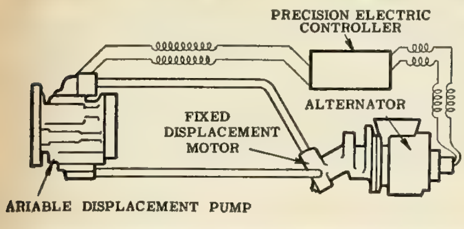

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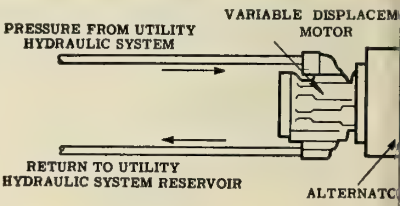
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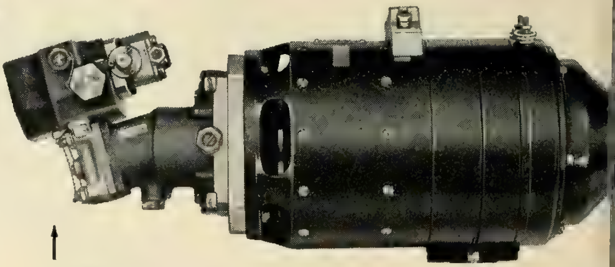

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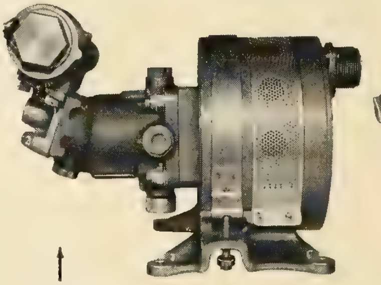
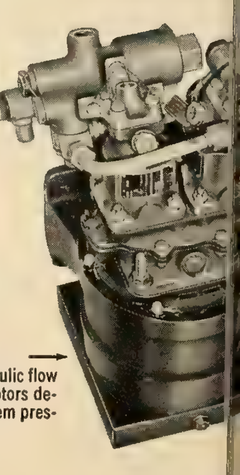


Frequency control ± 3%. Uses hydraulic flow control only. System pressure is constant.



Frequency control ± 3%. Uses hydraulic flow control to supply single or dual motors depending upon load variations. System pressure is constant.

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Coal's Place in Space: Rocket Fuels from Tars

Bureau of Mines Studies Hydrocarbon Fractions For Fuels of the Future

Howard W. Wainwright*

An intensive research program to find uses for the hydrocarbon fractions of low-temperature coal tars as high-energy rocket fuels is being conducted by the Bureau of Mines of the Department of the Interior.

This has been made possible by reviving interest in low-temperature (950°)F carbonization of both coking and non-coking coals because of the successful application of fluidized-bed techniques.

Fluidized carbonization offers new commercial markets for coal, and should allow it to play an important role as high energy rocket and jet fuels. However, regardless of the end use of the char, the tar must be utilized profitably before low-temperature carbonization processes can be established commercially.

The Bureau of Mines is researching the characterization and upgrading of tars from both experimental and commercial low-temperature carbonization processes. The hydrocarbon fractions amount to about 60-70% of the whole tar, and consist mainly of polycyclic aromatic and naphthenic compounds.

• **What's needed**—The key requirement for a high-energy fuel is a high heat of combustion, along with good thermal stability. An increase in energy content per unit volume or unit weight of fuel results in increased range and greater speed of the vehicle.

Other characteristics of the fuel that must be considered include freezing point, gravity, distillation range, aromatic and olefinic content, corrosion, smoke volatility index, additives and inhibitors.

However much research must be done before a completely satisfactory fuel is found that meets the stringent requirements of high-performance rocket and jet engines.

• **Solutions suggested**—The Air Force has suggested that "if these fuels are to remain principally in the hydrocarbon class, major inmprovements can be realized by several methods for their respective engines: 1) Selecting a pure hydrocarbon which will satisfy all the . . . requirements. 2) Systematic blending of hydrocarbons to produce a very precisely controlled mixture of known and unvarying composition, 3) Addition of non-hydrocarbon chemicals to hydrocarbon base fuels, and 4) Petroleum-derived chemical fuels."

The last possibility does not preclude the use of coal-derived chemical fuels. It appears that completely hydrogenated polycyclic aromatic hydrocarbons of the type found in coal tar may be desirable for this use.

B. F. Wilkes, of Development Headquarters, U.S. Air Force, told the Western Petroleum Refiners Association: "Widespread press releases about high-energy-exotic-ultra energy fuels have certainly increased public interest in fuels of all types.

"But be reassured the glamorized '20 mule-team' derived fuels, free radicals and ions won't replace, but will only supplement hydrocarbon fuels.

"Even for missiles, hydrocarbon fuels will long be with us. However, the way things change so fast nowadays, I must clarify this paper and state: 'This is good for 1 February 1958 only.' "

• **Research findings**—Bureau of Mines became interested in the possibility of using certain coal-tar fractions as jet and missile fuels through a U.S. patent (2,765,617) assigned to Monsanto Chemical Company.

Gluesenkamp and Kosmin, the inventors, proposed the use of perhydro-

Coal and Missiles—so far, a secondary relationship

It may be hard to visualize, but coal has a place in this nation's space program. The hardware sent into space, and most of the energy that powers these vehicles, come from prosaic holes in the earth.

Coal's first contribution—although an indirect one—is its use as a fuel for generation of electricity. Nearly 70% of the electrical energy generated by utility companies in 1957 was derived from 160 million tons, with a considerable amount of this channeled for use in the production of metals required for the space age. For instance, approximately 32,000 KWL is required to produce a ton of aluminum and a ton of magnesium. Approximately 1,200 KWH are required to liquify a ton of oxygen, and 15-20,000 to liquify a ton of hydrogen.

Coal also will contribute to the production of the "oxidizers"—fluorine and ozone. Approximately 6,000 KWH are required for the production of a ton of fluorine by the electrolytic method.

The fuels of the future may come by using low-temperature coal tar as the raw material. As pointed out in the accompanying article, fully hydrogenated polynuclear hydrocarbons appear desirable because of their high heating values per unit of volume, low viscosity, low vapor pressure, and low pour point. Some of these perhydroaromatics in coal such as decahydronaphthalene—have an advantage over petroleum fuels of the JP-types because of higher heats of combustion per unit of volume. Thus, there are bright possibilities for coal research.

**Chief, low-temperature tar laboratory, U.S. Bureau of Mines, Department of Interior.*

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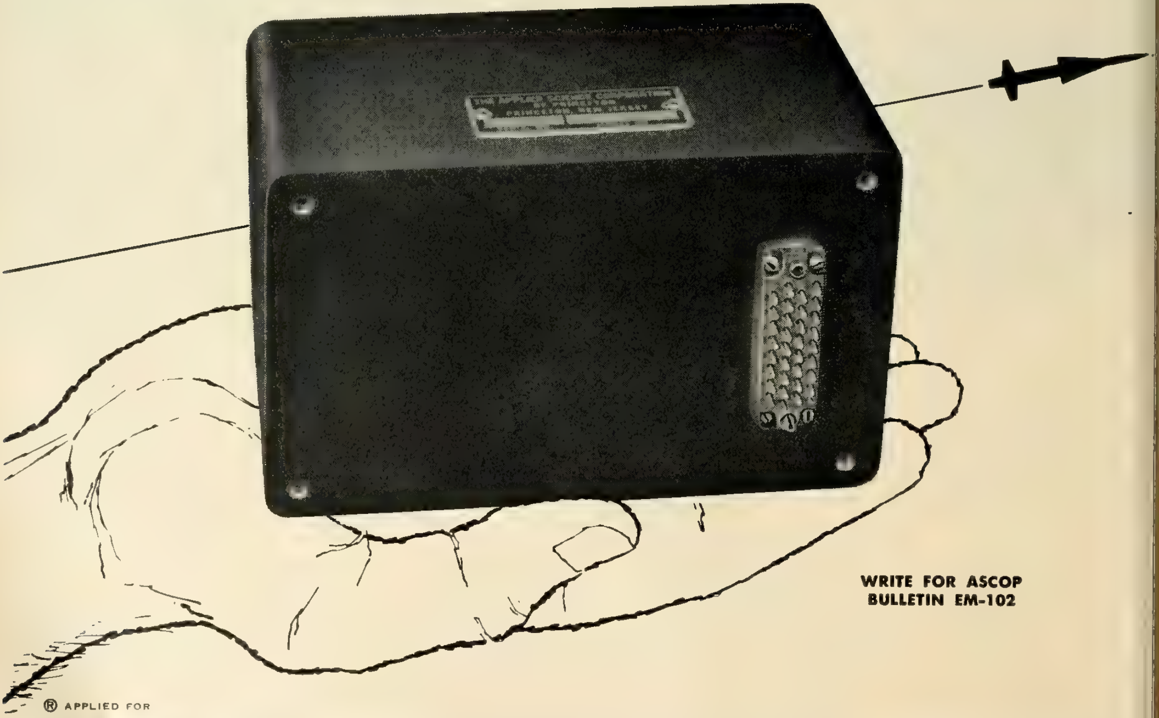

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condensed cyclic hydrocarbons as jet fuels. They proposed preparing the starting polycyclic aromatics by high-temperature pyrolytic decomposition of single-ring aromatics, such as benzene and toluene, and to hydrogenate the polycyclic aromatics at temperatures of 100°-250°C. and pressures up to 700 psig in the presence of a nickel catalyst.

One example cited in the patent is a mixture of solid hydrocarbons boiling above 350°C at 760 mm. pressure that was formed in the synthesis of biphenyl by the pyrolysis of benzene. This mixture was hydrogenated in the presence of a nickel catalyst until a product having the following properties was obtained:

Specific gravity at 30°C	About 1.004
Heat of combustion	145,500 B.t.u./gal.
Pour point	+5°C
Flash point	149°C
Flame point	200°C
Distillation range	About 340 to about 396°C

Although this product has a rather high pour point of 5°C, the inventors cite examples in which the pour points are as low as -70°C.

The products are characterized by combination of properties that render them eminently suitable for use as high-energy fuels for aircraft engines, and particularly for turbojet engines. These include:

1) A heat of combustion within the range of 125,000 to 160,000 B.t.u. per gallon.
2) A specific gravity at 30°C. in the range of 0.85 to 1.5.
3) Low vapor pressure or high boiling point.
4) Low viscosity
5) Low pour point.
6) Substantially no sulfur or vanadium compounds.
7) No water.
8) Burn cleanly without substantial formation of solid combustion products.
9) Uniform materials with relatively narrow boiling range.
10) Substantially free from straight-chain and/or branched-chain aliphatic hydrocarbons except when blended with other materials.
11) Substantially non-corrosive.
12) Substantially non-gum forming.

• **Sources**—The inventors point out that the starting polycyclic aromatic hydrocarbons can be obtained from coal-tar or petroleum fractions. They believe that coal-tar stock hydrogenation products would probably have good heats of combustion, but unless carefully selected, would probably have rather high points.

There exists in crude low-temperature coal tar a certain amount of fully hydrogenated polycyclic aromatic hydrocarbons of at least two rings, such as decalin, but the majority of the hydrocarbons present are polycyclic aromatics with varying degrees of saturation and containing up to 7 rings per molecule. These include anthracenes, phenanthrenes, fluoranthenes, pyrenes, chrysenes, benzfluorenes, and many others.

Although polycyclic aromatics have high decomposition temperatures, their use as fuels is unsatisfactory because of excessive carbon deposition upon combustion. Also, the corresponding hydrogenerated derivatives have considerably higher heating values; perhydrofluoranthene, for example, has a heat combustion of 18,130 B.t.u./lb, or 148,450 B.t.u./gal.

An important feature about the composition of low-temperature coal-tar hydrocarbons, insofar as high-energy fuels are concerned, is their high degree of alkylation. Alkylation generally improves the quality of a fuel by lowering its freezing point and viscosity and increasing its heating value per unit weight and per unit volume.

Ring analysis on certain low-temperature coal-tar pitch fractions showed them to consist of heavily alkylated anthracenes and phenanthrenes—the alkyl groups, for the most part, being

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This is one of a series of professionally informative messages on RCA Moorestown and the Ballistic Missile Early Warning System.

BMEWS AND THE SYSTEMS ENGINEER

Military science, in its need for large-scale, complex automatic equipment, has provided the environment for the evolution of the modern systems engineering concept. To meet the challenge of defense electronics particularly, this comprehensive and logical approach to engineering has steadily grown into a discipline in its own right.

BMEWS, a military electronics system of immense proportions, requiring the cooperative development efforts of four major corporations operating under RCA leadership, vigorously demonstrates the role of systems engineering in modern technology. Conceived by the Department of Defense and RCA systems engineers in 1955, BMEWS is evolving from mathematical model to hardware maturity entirely within the framework of the systems concept. The systems engineer is using his special tools of information theory, computing, probability, operations research, linear programming and other techniques to resolve the complex challenges of early detection of enemy ICBMs.

As an architect of defense, the RCA Moorestown systems engineer is also giving close scrutiny to the equipment requirements of the space vehicle age and to the physics of the generation of weapons beyond.

Engineering scientists who are interested in joining the Systems Engineering activity at RCA Moorestown are invited to address inquiries to Mr. W. J. Henry, Box V-13K.

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no larger than the ethyl group.

This alkylation undoubtedly will persist throughout the higher molecular weight hydrocarbons present in low-temperature tar. These alkyl groups will probably be preserved during hydrogenation as alkyl groups, as aromatic nuclei generally are resistant to hydrogenation.

• **Not from petroleum?**—Robert A. Wells of the Gulf Oil Research Center, recently stated that "Unfortunately, with hydrocarbon fuels from petroleum as the B.t.u./gal. increases the B.t.u./lb. decreases and aircraft range moves along the same lines . . . This condition does not remove hydrocarbon fuels from the realm of high-energy fuels but pretty well rules against hydrocarbons directly from petroleum.

"Fortunately, there are several hydrocarbons which can be synthesized from coal and petroleum chemicals which branch off from this seesaw and yield fuels with both higher B.t.u./gal. and B.t.u./lb." Perhydrofluoranthene, mentioned above, is one of these hydrocarbons.

How successfully can these selected coal-tar fractions be hydrogenated?

Although the Bureau has no experimental results at present, some indication can be obtained from a recent patent of the Coal Tar Research Association in England. This patent is concerned, in part, with improvements in producing fully hydrogenated polynuclear aromatic hydrocarbons from aromatic hydrocarbons, or their partially hydrogenated derivatives, present in coal tar.

The process consists in passing the hydrocarbons in the vapor phase over a hydrogenation catalyst at 20-100 atmospheres partial hydrogen pressure and temperatures of 200-500°C. A tar fraction boiling between 200-280°C. containing mainly napthalene and methyl napthalenes gave a 95% fully hydrogenated product. A fraction of boiling range 300-380°C., consisting mainly of anthracene and phenanthrene, gave a product of 84% fully hydrogenated material.

• **Russians on track**—The literature reveals that a considerable amount of work is being done in Russia on hydrogenating high molecular weight aromatic hydrocarbons from both petroleum and coal tar. Recent work has been done on a hydrocarbon fraction consisting of polycyclic aromatic and naphthenic rings having aliphatic side chains.

The side chains represented, on the average, 47 to 60% of the molecular

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weight. Hydrogenation converted the aromatics into polycyclic naphthenes containing 4 to 6 rings per molecule. Sixty percent of molecular weight of these polycyclic naphthenes was represented by paraffinic side chains, indicating that the side chains present in the feed material were not removed during the hydrogenation.

• **Sulfur is problem**—It is realized that the hydrogenation of coal tar-derived stocks, or the equivalent hydrogenation feedstocks from aromatic cuts of refinery products, might prove to be somewhat troublesome owing to the presence of sulfur compounds. Also, it might prove difficult to obtain precisely controlled hydrogenated fuels in view of the usual variations in the feedstocks.

There is a strong possibility that the selected coal tar fractions need not be limited to polycyclic aromatic and perhydroaromatic hydrocarbon fractions, but can also incluse mono-and dihydric polycyclic phenols. Laboratory results have showed that the same complexity of structure apparently persists throughout all classes of compounds in the tar, and that if a particular structure is found for one class of compounds, this structure will likely exist in other classes.

Little is known of the composition of the higher molecular weight phenols in coal tar, but it would appear that if a particular polycyclic aromatic hydrocarbon is present in the tar, the corresponding polycyclic phenol will also be present.

Experimental results have proved the presence of biphenyls and alkylated naphthalenes in low-temperature coal tar. Also, the corresponding alkylated naphthols, such as 2-methyl-1-naphthol and 4-methyl-1-naphthol, and o-and p-phenanthrols, and even higher molecular weight phenols are present.

It may be possible through a one-step hydrogenation process to remove the hydroxyl group from these polycyclic aromatics and simultaneously hydrogenate them to the corresponding perhydroaromatics. The significance o this lies in the fact that, in chemica processing, a class separation between phenolic material and hydrocarbon would not be necessary.

However, much research is neede to prove the feasibility of such a process. Some work on the reduction o polycyclic phenols is reported in th literature. Pelletier and Locke of th Rockefeller Institute have publishe their work on the reduction of polycyclic phenols to hydrocarbons, an Russian information also is available.

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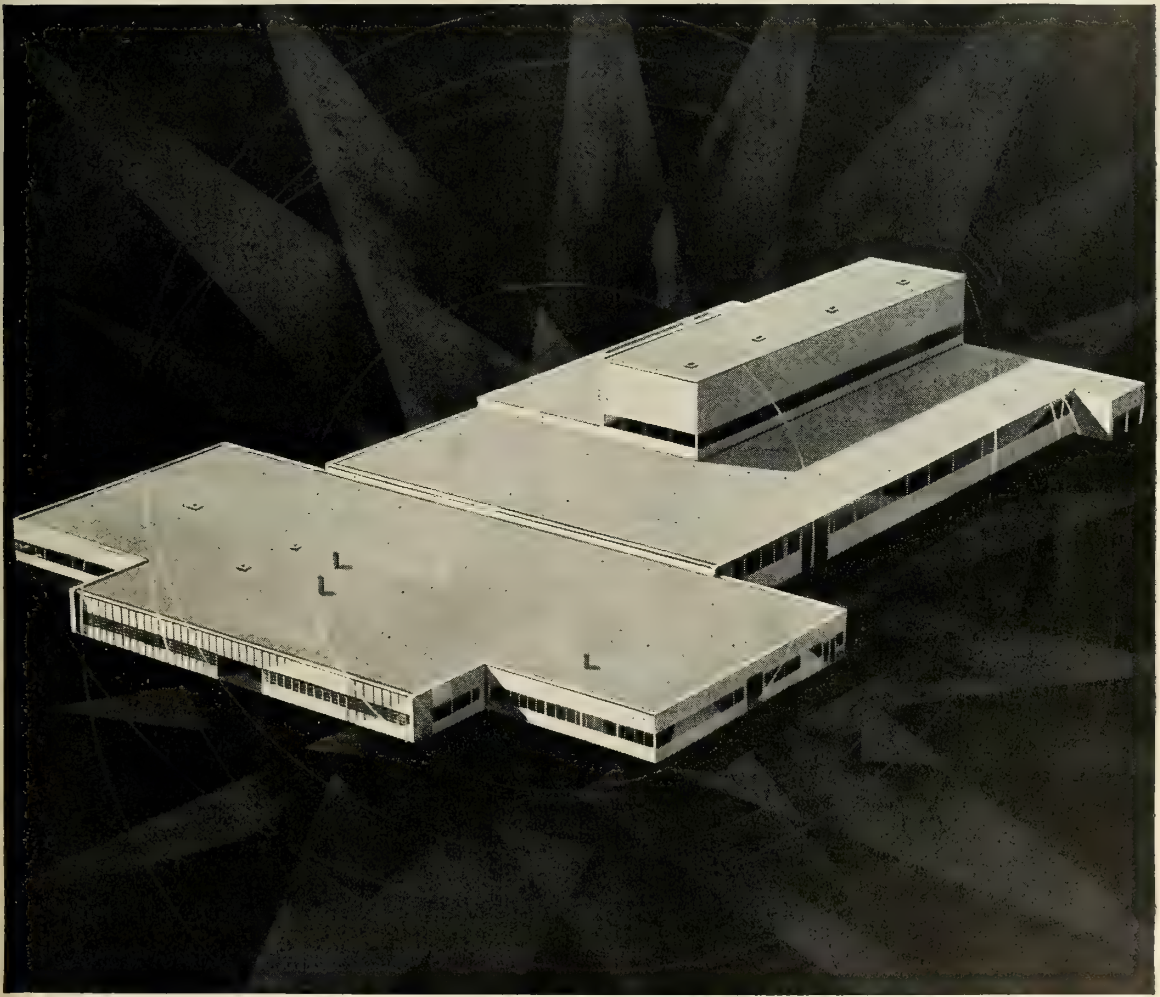

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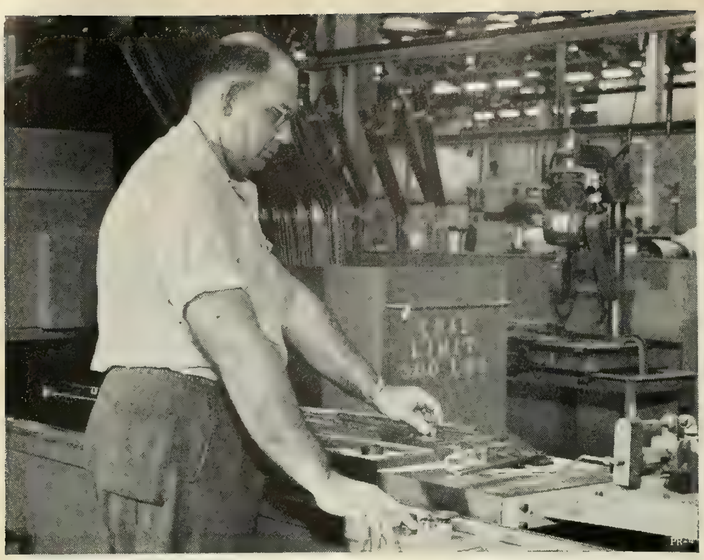
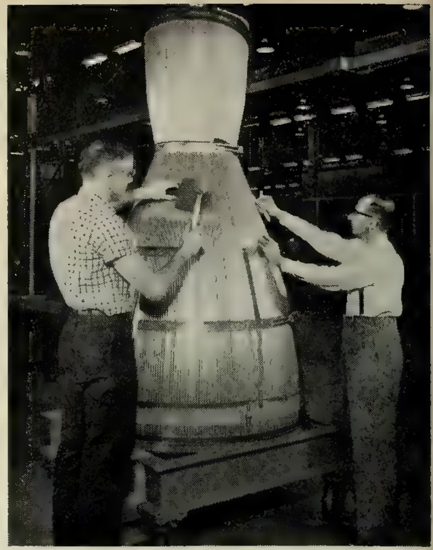


ROUND NICKEL TUBES, .045 in diameter, are pressed into rectangular form.



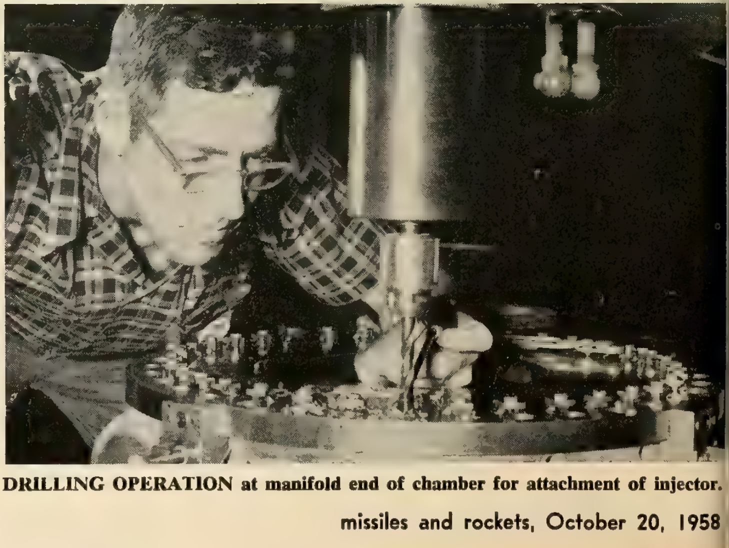
FORMED TUBES are stacked on mandrel.

Assembly Line Produces Rocket Engines

Thin nickel tubes, brazed with solder and held in place with thin steel bands, form the envelope for the United States' largest liquid propellant rocket—in production for *Thor, Thor-Able, Atlas* and *Jupiter*.

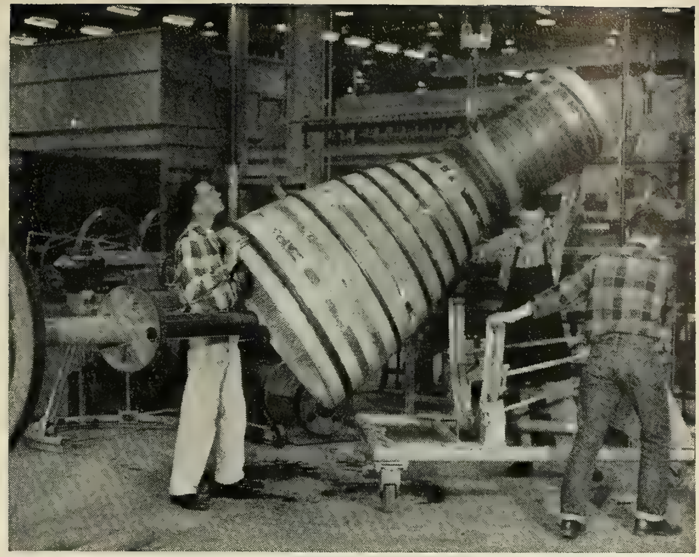
by Norman L. Baker

PENETRATION of solder checked by X-ray.



DRILLING OPERATION at manifold end of chamber for attachment of injector.

MOST CRUCIAL operation is tube soldering.



THRUST CHAMBER is mounted on large lathe for manifold preparation.

Neosho, Mo.—The Air Force lunar probe attempt of August 17 was started on its way by the first production rocket engine to roll from Rocketdyne-Neosho's assembly lines.

The largest single chamber unit in production in the United States, its status as a mass assembly item represents one of the most radical advancements in missile technology. The technique employed in fabrication is a unique approach to the weight/cooling problem that has plagued engineers for many years.

Although the Neosho engines are being produced for the *Thor* IRBM, similar construction is used on the booster and sustainer engines for the *Atlas* ICBM and the Army-developed *Jupiter* IRBM. Major differences in the engines are in the propellant feed system. Fabrication of the thrust chamber proper is, for all practical purposes, identical.

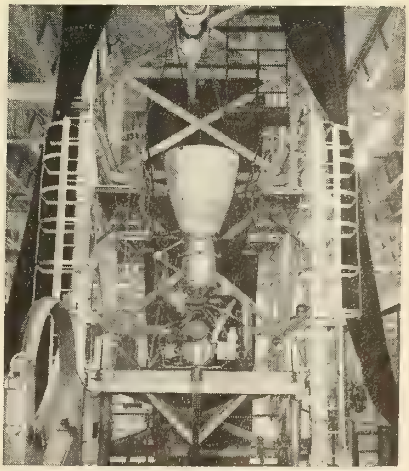
Round nickel tubes, .045 inches in diameter, form the envelope for the combustion chamber, nozzle and exit area of the thrust chamber. The tubes are changed to rectangular form in a tube press, which not only changes the tubes from straight and round to rectangular, but to the exact cross-sectional contour of the chamber.

After the pressure forming, the tubes (approximately 300) are placed against a torch-weld jig and held in place with steel bands for the welding operation. The tubes are joined in the jig by brazing with silver solder.

Approximately $300 worth of solder is used in this operation. The steel bands holding the tubes in position are welded to the tubes at intervals as reinforcing bands to absorb the stress resulting from the combustion pressure and heat expansion. In the region of the combustion chamber, the reinforcing bands form a solid continuous band.

Following the brazing/welding operation, manifolds are attached to the ends and the injector plate mounted into position. After X-ray examinations, pressure checks and cold flow tests, the thrust chamber is ready for the installation of the main propulsion package of turbo pump, gas generator, main lines.

HOT AIR HEATER dries thrust chamber after cold-flow calibration.



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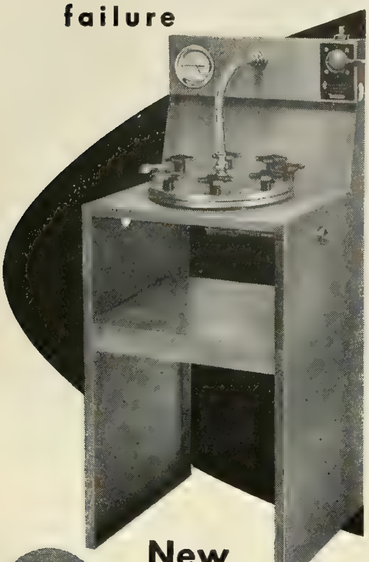

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space age

by Norman L. Baker

CETEX Committee—A number of scientists planning for the first landings on the moon have expressed concern unless proper precautions are instituted to prevent undesirable contamination from terrestrial sources. To meet this problem, the International Council of Scientific Unions (ICSU) set up a committee on Contamination by Extra-Terrestrial Exploration, under the auspices of COSPAR (Committee on Space Research), to specify conditions of landing that would keep contamination to acceptable levels. The second lunar probe attempt by the Air Force, anticipating a 25% possibility of impacting the lunar surface, had its payload sterilized with a DDT-type of disinfectant.

Shades of negligence—The reason for the Air Force's first lunar probe failure has finally been determined. An instrument package, reportedly attached to a frail oil line feeding one of the propellant turbine bearing mounts, produced such severe vibrations during the first stage engine firing that the line separated, starving the bearing of oil. After a few seconds, the bearing froze, either stopping or drastically slowing the turbine until upstream pressure forced a line system to give way.

van Allen Belt major experiment—The first stage engine modification requirement was only a secondary reason for postponing the planned September lunar shoot. The van Allen-Singer recommendation that vertical high altitude probes be made of this radiation belt to determine its limits apparently were recognized by the Air Force lunar team. Their determination to modify the scanner-magnetometer payload, as engineered for the first attempt to include radiation counters, forced an understandable stretch-out of the originally planned program. Main question—is the 40,000 mile line, as theorized by Singer, the limit of the radiation belt or does it continue to an infinite limit in space?

Russia's next move?—Albatoli A. Blagonravov, *Sputnik* scientist, has repeatedly denied that Soviet scientists have experienced failures during their satellite program. If this is a fact, it would indicate a thoroughness of pre-countdown check-out and rocket component reliability not practiced in this country. As for the nearness of the next Soviet space venture, Leonid Sedov alerted us with his statement that unmanned space flights to the Moon, Mars and Venus would be made "within the nearest future." Early in September 1957, the Russians announced they would attempt to launch a satellite in "the near future"—a report American scientists took too lightly.

X-15 apologies—This column erroneously reported Sept. 8 that the Reaction Motors Division of Thiokol was being assisted by North American's Rocketdyne Division in the development of the first X-15 60 k rocket engine. A back-up Rocketdyne engine is under development, but the first engine development was Reaction's. X-15, rolled out on Oct. 15, was equipped with an XLR engine (type used on earlier X-series craft), which will be replaced before first powered flights by the Reaction powerplant.

Silent satellite—*Explorer* IV, with an estimated life of six years, has joined *Explorer* I as space debris. Its second transmitter ceased operating profitably two weeks before the final signal was heard. The signals during the last days of power life were unintelligible, serving only as an aid in tracking. The satellite's original tracking transmitter quit transmitting September 9.

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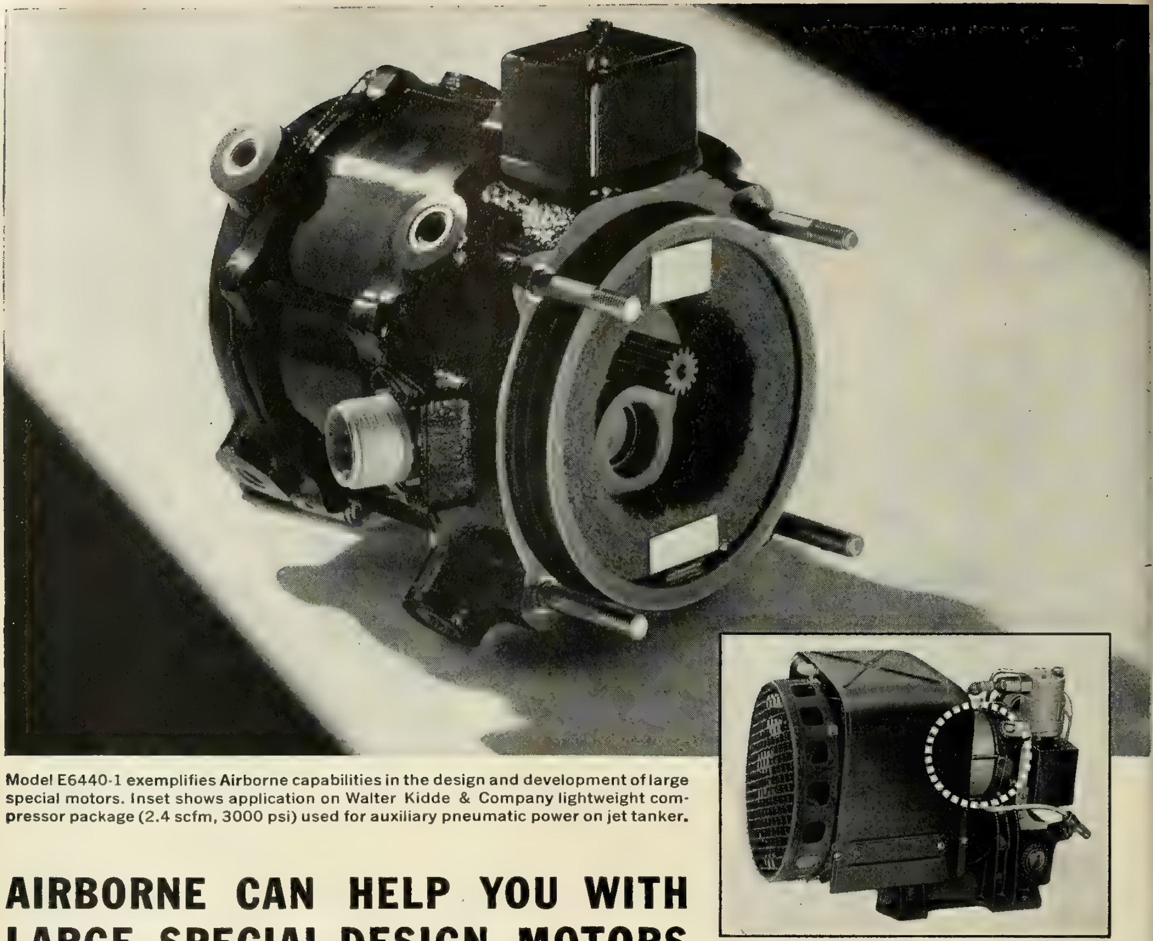

Model E6440-1 exemplifies Airborne capabilities in the design and development of large special motors. Inset shows application on Walter Kidde & Company lightweight compressor package (2.4 scfm, 3000 psi) used for auxiliary pneumatic power on jet tanker.

Photo courtesy Walter Kidde & Company, Inc.

AIRBORNE CAN HELP YOU WITH LARGE SPECIAL-DESIGN MOTORS

Airborne can design and develop almost any type of large special motor you need and supply it in any quantity you require. Evidence of this capability is found not only in current projects, but also in the many different motors developed over the years for use on our own actuators and electromechanical systems.

Typical of the large special motors designed and produced by Airborne is the one above developed for Walter Kidde & Company to power one of its outstanding lightweight compressor packages. Special features include magnesium castings for weight savings; modified high-temperature insulation and lubricants; and a special thermal overload protector (Type C protection) to prevent winding damage at temperatures above 400°F.

Whatever your particular requirements in large special-design motors, it will pay you to consult Airborne. Chances are we can solve your problem in good time and at reasonable cost. Write, phone or wire for more information.

GENERAL ENGINEERING DATA

Airborne Special Design Motor E6440-1

1. 115/200 v a-c, 400 cycle, 3 phase (conforming to MIL-M-7969A)
2. Rated 1.7 hp at 10,900 rpm—10 in-lb full load torque; 25 in-lb starting torque
3. Duty cycle: 30 min. on at full load/30 min. off
4. Ambient temperature: −65 to +165°F
5. Altitude: to 50,000 ft
6. Weight: 8.8 lb

See us at the Aircraft Electrical Society Show in Los Angeles

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AIRBORNE®

AIRBORNE ACCESSORIES CORPORATION

HILLSIDE 5, NEW JERSEY

NEW CATALOG SAM-58

Describes Airborne special actuators and motors. Write for a copy today.

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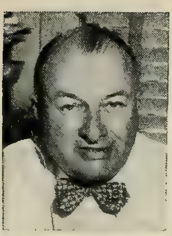
missile business



by **Fred S. Hunter**

Some years ago, Robert E. Gross almost put together a merger of Lockheed Aircraft Corp. and Hughes Aircraft Co. The late Harold Talbott, then secretary of the Air Force, blocked it. Talbott didn't think it would be good for the government to have a prime contractor operating a major electronics facility turning out components for other prime contractors.

Gross, who thinks in big terms, had gone after Hughes because it had become a big company, making big inroads into the electronic and missile fields. At the same time, Gross felt Lockheed was lagging behind some of the other companies in the industry. Since then, of course, Lockheed has more than caught up by the successful organization of its own Missile Systems division.

But another reason Gross and the Lockheed people liked the idea of buying the Hughes Aircraft Co. was to give Lockheed a ready-made start in electronics and missiles. There was only one stockholder to worry about. Howard Hughes was the sole owner of the Hughes Tool Co. of which the Hughes Aircraft Co., at that time, was a division. Once a price was reached with Howard Hughes only legal formalities would have remained to complete the consolidation of the two companies.

Working out a big merger is an extremely difficult job. There's much more to it than an examination of a couple of financial statements. There are such considerations as location, facilities, labor agreements, management characteristics, workloads and countless legal details. After you settle all these, you start studying the stock structures. And here's where many proposed mergers fall apart. You have to have a deal that fits two sets of stockholders.

Witness the attempts of Whitley C. Collins to bring about a merger that would make Northrop Aircraft bigger and better. He had a consolidation with Vertol Aircraft Corp. all but finalized, only to have to call it off at the last minute because no satisfactory way could be found to mesh the stock structures of the two companies. Recent negotiation with American Bosch Arma ended the same way. The two companies were unable to agree on several points, but the big stumbling block was the exchange of stock.

Gross would still like to bring an electronics company into the Lockheed fold. He has engaged in talks with several companies. Not long ago a financial commentator attributed the strong position of Lockheed's stock to the possibility of a merger with the Hazletine Corp. There also have been reports of talks with Sylvania Electric Corp. Whether anything may materialize from these or any of the conversations Gross may be having elsewhere remains to be seen. But they represent a further illustration of the difficulties that are encountered in trying to bring about a favorable merger when companies of the scope of Northrop or Lockheed are involved.

Company briefs: Polarad Electronics Corp. reports a new peak in sales —$9.6 million—for the fiscal year ended June 30, 1958 . . . **Temco Aircraft Corp.** has arranged to acquire $5 million in capital through first mortgage and 5¼% sinking fund bonds, to finance a new office building and engineering center . . . **Solar Aircraft Co.** announces it is building gas turbine-powered pulse generators, for use by Navy in mine-destroying units for Navy minesweepers . . . **American Welding Society** has issued specifications for low-alloy steel electrodes, insisting, among other matters, that electrodes must now meet chemical as well as mechanical requirements . . . **Lukens Steel Co.** has succeeded in rolling what it calls the widest sheet of high strength steel ever produced, for use in rocket motors. Sheet is 160 in. wide.

Work where
PUMP ENGINEERING
reaches its peak!

It takes exceptional pumps to feed the most powerful propulsive system ever built—the Large Rocket Engine. And it creates an exceptional career for the man who develops these pumps.

Rocket Engineering offers the most interesting opportunities in the pump engineering field today. Your experience with commercial pumps and compressors will be extremely useful—to help solve problems of head capacity, power and speed never before encountered. You'll gain technical and professional experience that is unobtainable elsewhere...your contributions to the advanced techniques of pump design will be recognized and rewarded.

Rocketdyne builds high-thrust rocket propulsion systems for America's major missiles. You'll work with the leading producer in the nation's fastest growing industry.

If you are an experienced pump engineer with the ambition to break new ground, tell us about yourself. Chances are your creative ability can open up a new career for you in Rocket Engineering — more fascinating and more valuable to you than the work you are now doing. Write: Mr. D.K. Jamieson, Rocketdyne Engineering Personnel, 6633 Canoga Avenue, Canoga Park, California.

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.
BUILDERS OF POWER FOR OUTER SPACE

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ARMY

Ford Instruments Company, Division of the Sperry Rand Corporation, Long Island City, New York, was awarded $1,209,277, details of which are classified.

By Headquarters, Redstone Arsenal, Ala.:

Firestone Tire and Rubber Co., Guided Missile Div., Los Angeles, Calif., received $34,627 for furnishing to the government twenty-four (24) man-months of technical services of full qualified field engineers and services, to be utilized in connection with courses of instruction and programs for training groups of military and other personnel.

Philco Corp., Philadelphia, Pa., received $46,499 for furnishing and supplying manhours of fully qualified technician instructors to the U.S. Army Ordnance Guided Missile School.

By U.S. Army Engineer District, St. Paul,. Minn.:

Power Engineering Co., Inc., Sioux City, Iowa, received $46,500 for construction of Anti-Intrusion System for Launcher Boxes, Minneapolis-St. Paul Defense Area.

By San Francisco Ordnance District, Oakland, Calif.:

Lockheed Aircraft Corp., Missile Systems Div., Sunnyvale, Calif., received $58,317 for Missile Borne Television Systems (*Jupiter* Missile Program).

By U.S. Army Ordnance District, Philadelphia:

Douglas Aircraft Co., Inc., Charlotte Ordnance Missile Plant, Charlotte, N.C. received $36,939 for *Nike* Spare Parts and Components.

Douglas Aircraft Co., Inc., Charlotte Ordnance Missile Plant, Charlotte, N.C. received $23,131 for *Nike* Spare Parts Components.

Douglas Aircraft Co., Inc., Ocean Park Blvd., Santa Monica, Calif. received $18,539 for Blue Streak & Emergency Spare Parts.

AIR FORCE

By AFB Cambridge RC, ARD&DC:

Sylvania Electric Products, Inc., Waltham, Mass. received $48,708 for a study of electromagnetic and magnetohydrodynamic properties of ionized gases associated with high speed missiles.

By Headquarters, AFOSR, AR&DC:

Vitro Laboratories, Div. of Vitro Corp. of America, received $66,111 for research on "Energy Exchange in High Intensity Arc Plasma."

By Oklahoma City Air Material Area, Tinker AFB, Okla.:

Hayes Aircraft Corp. received $28,699 for overhaul and repair of fuel valve assembly.

NAVY

By District Public Works Officer, Sixth Naval District; Charleston, S.C.:

Seth E. Glen and Associates, Memphis, Tenn., received $167,490 for Minitrack Facility, Receiver Site at the Naval Silver Lake Site, Greenville, Miss.

By Bureau of Ships:

Roller Smith, Inc., Newark, N.J., received $334,747 for switchboards for *Terrier* guided missile fire control system.

AIR FORCE

By Air Force Office of Scientific Research:

Vitro Laboratories, Division of Vitro Corp. of America, West Orange, N.J., received $66,111 for research on "Energy Exchange in High Intensity Arc Plasma."

Ohio State University Research Foundation, Columbus, received $49,464 for continuation of research on "Certain Phases of the Interactions Between Electromagnetic Radiation and Matter."

Atlantic Research Corp., Alexandria, Va., received $49,862 for continuation of research on solid propellant combustion.

GROUND HANDLING EQUIPMENT "FLIES"

with an assist from Binkley Landing Gear-Leveling Jack

A giant Thor transporter-erector is shown being loaded abroad an aircraft for transportation anywhere in the world. This is real mobility! And Binkley helps make it possible by supplying the landing gear for this surface handling equipment.

Custom-designed for Food Machinery and Chemical Corporation, the Binkley mechanism has a capacity of 100,000 lbs. and is capable of manually lifting and leveling weights up to 18 tons.

Binkley has specialized in the design and maunfacture of similar parts and components for truck and trailer bodies during 25 years service to the transportation industry. Put that experience to work for you! Call or write today for prompt and confidential attention to your ground handling equipment problem.

Binkley

Serving the transportation industry since 1933
MANUFACTURING COMPANY Warrenton, Mo.

WEST COAST REPRESENTATIVE: Walter Weyman Company
2216 Fifth St. • Berkeley 10, Calif. • THornwall 5-3990

Circle No. 12 on Subscriber Service Card.

The Mobile Missile Market

Like a mobile . . . the missile market is made up of separate parts and different elements. Many industries and thousands of companies compose the mobile missile market. Aircraft companies build missile frames and prime systems. Automobile companies manufacture missile systems . . . a cereal company builds missile subsystems.

And like a mobile . . . there is constant movement and change in the missile market. New developments happen fast. That's why missile men in management, engineering, production and procurement need an undiluted missile book to be posted constantly and accurately. Throughout the complex market missile men look to MISSILES AND ROCKETS as the number one missile book.

MISSILES AND ROCKETS

AMERICAN AVIATION PUBLICATIONS, INC.
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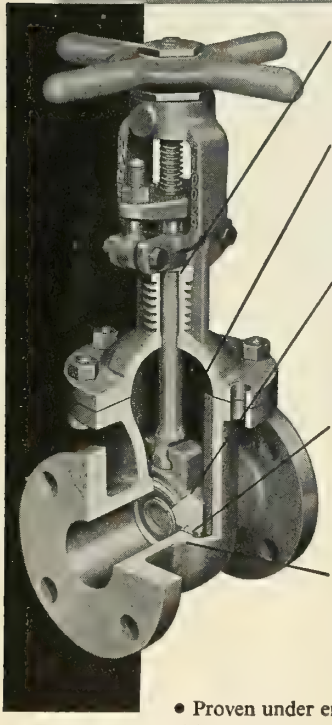
ABC
ABP

For Safe, Leakproof Shut-off of Liquid Fuels

SPECIFY:

Hamer Vented Chest GATE VALVES



Chevron Packing
Expands as pressure increases to prevent escapage at stem.

Chest Vented to Pipe Line
Seal on one side vents chest to pipeline, thus preventing locked-in pressure buildups.

Micro-finish Wedge
Seating surfaces are precision finished for exacting metal to metal fit against seats.

Positive Shutoff Seal
Located in one side of the wedge only, this seal compresses against valve seat forming an absolute shut-off.

Integral Body Seat
Integral design eliminates threads, welds & other objectionable surface irregularities.

- Proven under environmental field conditions, these contour engineered Gate Valves seal equally well with line flow in either direction. Seal in one side of wedge vents valve chest to pipeline preventing dangerous pressure buildup. Valves are available in various sizes in a range of metals. Write today for literature and the name of your nearest Hamer representative.

Send for *FREE* Bulletins LTG, VCG ▶

Hamer *VALVES INC.*

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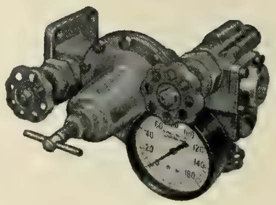
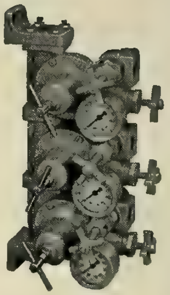
ENGINEERED MANIFOLDING

BY REPUBLIC

SAVES SPACE
WEIGHT
INSTALLATION COST
MAINTENANCE

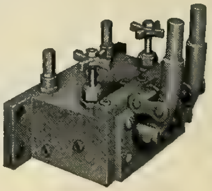




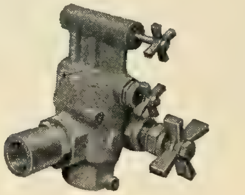
AIR CONTROL MANIFOLDS

Concentrates air controls by combining line shut-off valve, pressure regulator, blowdown valve, check valve, gage shut-off and gage. Eliminates leakage and external connections. Easily maintained. Saves much space and downtime. Units interchangeable. Can be multiple-mounted by use of headers.

DUAL HAND PUMPS



2 double-acting hand pumps, 2 gages, 2 relief valves, and 2 needle bleeder and shut-off valves, completely manifolded, for missile ground support equipment. All valve adjustments readily accessible.



RELIEF MANIFOLD

Pilot-operated relief valve, check valve, flow control valve and by-pass valve combined to facilitate test-stand operation. Gives quick, easy control of both flows and pressures.

● **MANIFOLD COMPONENTS,** engineered for a specific application, is a Republic specialty. Modern design demands a new dimension in space, weight, installation, and service. Let our valve specialists solve your specific compacting problem.

282

RM **REPUBLIC MANUFACTURING CO.**
15655 BROOKPARK ROAD • CLEVELAND 35, OHIO

Circle No. 14 on Subscriber Service Card.

new missile products

Accelerometer Has Low Cost Sensitivity

Lind Corporation, Princeton, N.J. has put on the market the type TA2 accelerometer. The new unit is a seismic mass system which possesses low cross sensitivity by virtue of the high transverse stiffness of the self compensating E springs.

It is totally immersed in a silicone fluid with a viscosity selected to provide a damping ratio of 0.65. Volumetric changes in the oil with temperature rise are compensated by expansion chambers in the case. This allows an operating temperature range from –40°C to +100°C. Dual pots are provided for high level, redundant output. According to Lind, life tests reveal that units can stand 10 million reversals without affecting calibration.

Circle No. 231 on Subscriber Service Card.

Transfer Digital Circuits In Two Packages

The Components Division of Epsco, Inc., Boston, Mass., has placed on the market a complete line of transistor digital circuits in two package styles and three temperature ranges.

Package Style A is for mounting in 9 and 14 pin miniature tube sockets. Package Style B is for 15 pin in-line mounting. The three available temperature ranges are: –10° to +60°C, –10° to +71°C, –55° to +71°C. The circuits are designed for 100 KC operation, but permit operation up to 200 KC, and in some cases, up to 400 KC. A duplicate line of one megacycle circuits is being engineered.

Available circuits are flip-flops and counters, diode and gates, diode or gates, nor gates, parallel gates, cascade gates, inverter amplifiers, non-inverting amplifiers, emitter followers, power drivers, one shot delays, pulse shapers, level converters, neon indicators, incandescent indicators, blocking oscillators, level shapers, 6, 12, 18 volt power supplies, and clock pulse generators (O-250C).

Circle No. 237 on Subscriber Service Card.

Disconnect Coupling Stands 22,000 psi

A new quick disconnect coupling for hydraulic and fuel lines in missiles which withstood 22,000 psi in a burst test, is in production at **On Mark Couplings, Inc.,** Los Angeles. Designated On Mark Type 5-5002-8, the new coupling may be connected and disconnected manually under high pressure through the elimination of commonly used steel balls and "dogs" which avoids inherent difficulties such as Brinell type indentures in the retainer seat. Remotely actuated couplings of this new design are also available.

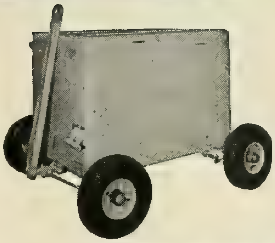
Even under high pressure this coupling may be connected simply by pushing the halves together, and disconnected without effort by pulling back on the actuating ring, with practically no loss of fluid. Locking mechanism is smooth and positive, will compensate itself as wear occurs, which assures utmost in reliability and long life since a full 360° gripping action is used. End fitting may be altered to suit various applications.

Circle No. 242 on Subscriber Service Card.

PRESSURIZATION!!!

Now get the facts on Kahn's versatile new Portable Air Stand. This dependable, portable equipment provides HIGH PRESSURE – dry air or nitrogen for pressurizing aircraft or missile systems.

- 4-Stage Compressor delivers 15 SCFM of dry air at pressures to 5000 PSIG.
- Kahn's High Pressure Automatic Dryer provides dryness of minus 65 degrees F. or lower dew point.



KAHN'S HIGH PRESSURE PNEUMATIC ACCESSORIES TEST STAND

Highly versatile 3-Station Component Test Stand delivers 5000 psi. air at minus 65 degrees F. dew point. Tests components such as Pressure Switches, Solenoids, Cylinders etc. KAHN'S INTERLOCK SAFETY feature prevents component tampering under pressure.

Inquiries Invited.

Kahn and Company, Inc. • 541 WINDSOR STREET
HARTFORD 1, CONNECTICUT

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DESIGN-ENGINEER & PRODUCTION OF AIRBORNE & GROUND SUPPORT EQUIPMENT

INERTIAL GUIDANCE
TRAINING

with BULOW
EQUIPMENT

MISSILE TRAINING EQUIPMENT . . . COMPLETE AND SUBSYSTEMS. FOR INERTIAL GUIDANCE CLOSED LOOP SIMULATION. DIRECT ALL INQUIRIES TO SYSTEMS ENGINEERING DEPARTMENT.

MISSILE TRAINING EQUIPMENT • GROUND SUPPORT TEST EQUIPMENT • COMPONENTS-PRESET TIMERS, TIME INTERVAL METERS, ANTENNAS, HEATER THERMOSTATS, TAPE READERS

BULOW ELECTRIC CO. 11000 CAPITAL, OAK PARK 37, MICH.

Circle No. 16 on Subscriber Service Card.

THOMPSON PRODUCTS NEEDED A HEATER FAST...

Here's how General Electric solved customer's heating problem—in 3½ days!

Recently, Thompson Products, Inc., ran into a problem: components were not available which would function at the extremely low temperature ambients required for a control being manufactured for a new USAF fighter. A holdup here could halt the entire aircraft program.

A General Electric sales engineer was called in. To General Electric's Specialty Heating Products plant at Coxsackie, N. Y. went a call. Asked the customer: "How soon can you design, develop and deliver a prototype heater for our airborne system component?" The General Electric answer "78 hours—3½ working days—after we receive your specs."

Project preparations started immediately. When the rough equipment sketches arrived, the team went into action. At 11:00 A.M. Thursday—3½ days later—the heating unit passed final inspection; was on its way. Final result: the aircraft program never slowed down.

THIS IS ONE EXAMPLE of how quickly General Electric can solve straight forward thermal conditioning problems. When you have a heating problem, call in your nearest General Electric sales engineer.

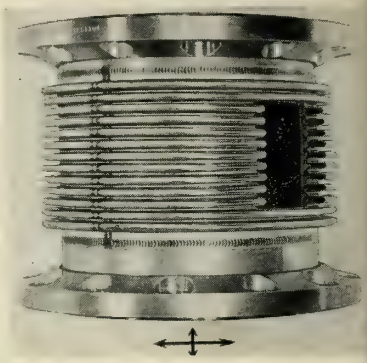
GENERAL ELECTRIC COMPANY
Section H220-14, Schenectady 5, N. Y.
Please send bulletin GEA-6285A, G-E Specialty Heating Equipment
☐ for immediate project
☐ for reference only
Name__________
Position__________
Company__________
City__________ State__________

Progress Is Our Most Important Product

GENERAL ELECTRIC

. . . new products

Flexible Connector Reduces Turbulent Flow



A new lined flexible connector has been designed by **Flexonics Corporation** for ducting systems of missiles and advanced aircraft. The lined connector greatly reduces turbulence and pressure drop through the flexible elements of the ducting system where turbulence of an undesirable degree was often set up in conventional flex sections.

The liner is an especially designed interlocked flexible tube, formed of stainless steel strip. The interlocking convolutions are an axial motion for which the connector is designed. The liner is relieved so that the corrugated element is the sole pressure carrier.

The lined flexible connector has proved especially useful in liquid oxygen systems, where it cuts turbulence and prevents cavitation in centrifugal pumps. It has also proved effective in pneumatic power piping, where it helps designers by eliminating some of the variables that result from pressure drop.

Circle No. 234 on Subscriber Service Card.

Kearfott Producing Miniature Servo Valves

Kearfott Co., Inc., Clifton, N.J., has in production miniature lightweight servo valves which, according to the manufacturer, by virtue of a totally new approach in the design of electrohydraulic feedback amplification has resulted in a servo valve having only two moving parts—the spool and the torque motor armature.

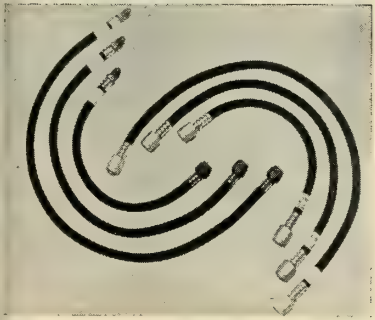
The new units are designed so that clogging and silting are effectively prevented through use of oversize orifices which also permit operation even with highly contaminated fluids. In addition to high frequency response, these units also exhibit minimum null shift.

Employment of unity hydraulic feedback eliminates springs, and compensates for pressure and temperature variations. Inherent unity feedback of spool position also reduces sensitivity to load, pressure, and vibration. Since control ports of these servo valves are of closed center design, quiescent flow is low, thus reducing pump requirements.

High flow rates are possible, ranging from O-2, O-5, and O-10 gpm at a supply pressure of 3000 psi. Supply pressures range from 500 to 3000 psi. The standard motor is a permanent magnet DC type. The four-way is free floating, accurately matched to its sleeve, and has inherent dither which acts directly upon it. The driving amplifier is somewhat simpler, since a dither signal need not be supplied.

Circle No. 240 on Subscriber Service Card.

Specialized Hose Assemblies for Missiles



Zep Aero of El Segundo, Calif., announces a new nylon covered tygon hose assemblies with An, MS, or special fittings. These hose assemblies are for use with oxygen and special corrosive fluids and gasses, burst pressures to 2000 P.S.I. and temperature range from —68 to +215°F. They are lightweight with extreme flexibility yet allowing minimum bend radius without collapsing—excellent shelf life far surpasses rubber compositions.

Circle No. 235 on Subscriber Service Card.

Sylvania Adds Ka-band Magnetrons for Missiles

Three new Ka-band magnetrons rugged enough for missile applications have been developed by **Sylvania Electric Products, Inc.**

The new tubes bring to five the number of magnetrons for Ka-band (33-36 kilomegacycles frequency) applications available from Sylvania. The new types—M4063 and M4155—plus the earlier 5789 and 6799, cover a power range from 20 to 100 kilowatts.

These tubes, developed at Sylva-

Major Southern California missile operation has **immediate openings** for qualified graduate engineers with experience in

Instrumentation Systems

with general knowledge of missile systems, including propulsion, guidance, structures and electrical systems.

Guidance Systems

Experienced in research and testing of practical hardware, and with mathematical background for systems analysis.

Flight Test

Background should qualify for planning and formulating entire flight test programs.

Aerodynamics

Must be able to analyze missile configuration to determine aerodynamic performance and stability and control characteristics.

For information on these and other engineering positions, write:

Mr. H. B. Richards, Dept. 451
Missile Division
North American Aviation, Inc.
12214 Lakewood Blvd., Downey, California

MISSILE DIVISION
NORTH AMERICAN AVIATION, INC.

Circle No. 17 on Subscriber Service Card.

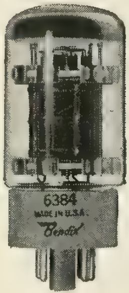
SPECIALLY BUILT TO WITHSTAND
SEVERE OPERATING CONDITIONS

Bendix Red Bank

HY-G-300®

HARD GLASS TUBES

6094
BEAM POWER AMPLIFIER


6384
BEAM POWER AMPLIFIER

6754
FULL-WAVE RECTIFIER

- Ideal for modern high-performance aircraft and missiles.
- Processing at higher vacuum and under the higher heat permitted by the hard glass reduces gas and contamination and provides greater operating stability at higher temperatures.
- Ceramic element separators prevent emission loss from high heat and vibration.
- Solid aluminum oxide heater-cathode insulator eliminates shorts, reduces leakage.

For complete line of tubes, write RED BANK DIVISION, BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY.

ELECTRICAL RATINGS*	6094 Beam Power Amplifier	6384 Beam Power Amplifier	6754 Full Wave Rectifier
Heater Voltage (AC or DC)**	6.3 volts	6.3 volts	6.3 volts
Heater Current	0.6 amp.	1.2 amp.	1.0 amp.
Plate Voltage (Maximum DC)	300 volts	750 volts	350 volts
Screen Voltage (Maximum DC)	275 volts	325 volts	—
Peak Plate Voltage (Max. Instantaneous)	550 volts	750 volts	—
Plate Dissipation (Absolute Max.)	14.0 watts	30 watts	—
Screen Dissipation (Absolute Max.)	2.0 watts	3.5 watts	—
Heater-Cathode Voltage (Max.)	±450 volts	±450 volts	±500 volts
Grid Resistance (Maximum)	0.1 Megohm	.1 Megohm	—
Grid Voltage (Maximum)	5.0 volts	0 volts	—
(Minimum)	–200 volts	–200 volts	—
Cathode Warm-up Time	45 sec.	45 sec.	45 sec.

*For greatest life expectancy, avoid designs which apply all maximums simultaneously.

**Voltage should not fluctuate more than ±5%.

MECHANICAL DATA	6094	6384	6754
Base	Miniature 9-Pin	Octal	Miniature 9-Pin
Bulb	T-6½	T-11	T-6½
Maximum Over-all Length	2⅞"	$3\frac{15}{32}$"	2¾"
Maximum Seated Height	2⅝"	$2\frac{15}{16}$"	2½"
Maximum Diameter	⅞"	$1\frac{7}{16}$"	⅞"
Mounting Position	Any	Any	Any
Maximum Altitude	80,000 ft.	80,000 ft.	80,000 ft.
Maximum Bulb Temperature	300°C	300°C	300°C
Maximum Impact Shock	500G	500G	500G
Maximum Vibrational Acceleration	50G	50G	50G

West Coast Sales and Service: 117 E. Providencia Ave., Burbank, Calif.
Canadian Affiliate: Computing Devices of Canada, Ltd., P. O. Box 508, Ottawa 4, Ont.
Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.

Red Bank Division Bendix AVIATION CORPORATION

Circle No. 18 on Subscriber Service Card.

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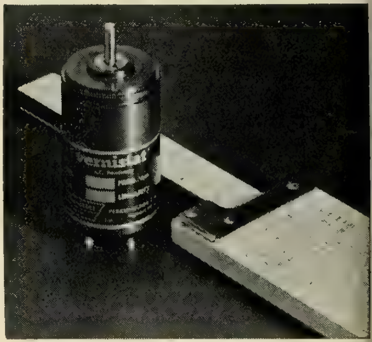
nia's Special Tube Operations plant in Williamsport, Pa., are used for radar equipment requiring very high resolution. As the source of the pulsed outgoing signal, they are the "heart" of a radar set.

Typical applications of the new tubes are in cloud-finding, mapping, and missile guidance equipment, according to the manufacturer. The 20-kilowatt M4063 weighs only nine pounds, while the 70-kilowatt type M4064 weighs 13 pounds. Between these is the 11-pound M4155, a ruggedized version of the 5789, with a rated peak output power of 40 kilowatts.

Circle No. 236 on Subscriber Service Card.

Vernistat Potentiometer Made By Perkin-Elmer



A new miniaturized version of the precision Vernistat a.c. potentiometer has been developed by the **Vernistat Division of the Perkin-Elmer Corp.,** Norwalk, Connecticut.

The Series 4 Vernistat potentiometers are size 11 components (1.062-inch diameter, with a weight of only two ounces. They are available with maximum output impedances of 200, 100, and 40 ohms, combined with high input impedance, and low output quadrature. Minimum output voltage increment (resolution) is 0.01% and terminal linearity is 0.05%.

The Series 4 also can be produced in nonlinear versions with 30-chord accuracy.

The new series operates in essentially the same manner as the Series 1 and 2 Vernistat potentiometers, and according to manufacturer combines the best features of a multiturn interpolating potentiometer with a precision multi-tapped autotransformer, for relating mechanical shaft rotation to a voltage. Applications for the Vernistat are found in servo systems, control systems, and analog computers. Among the military systems in which it is currently being used is the *Atlas.*

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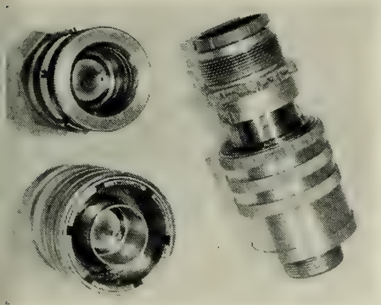
Quick-Disconnect Unit For High Pressures



A high temperature (+400°F), high pressure (3,000 PSI), self sealing quick disconnect coupling has been developed by **Arkwin Industries, Inc.,** for use with hydraulic fluids such as OS-45, Oronite 8515, and MIL-H-5606A oil.

The unit is said to be capable of operation in a temperaure range of –65°F (54°C) to 400°F (+204°C). Two classes of Tpye III system quick disconnect couplings are available according to the company:

A. Class 600-Six hundred PSI rated pressure furnished in 1¼, 1½, and 2 inch tube sizes.

B. Class 3,000-Three thousand PSI rated pressure furnished in ¼, 3/8, ½, ¾, and 1 inch tube sizes.

When MIL-L-7808 synthetic oil is used, the quick disconnect coupling conforms to Military Specification MIL-C-7413A (USAF) dated 5 October 1955 and is for use in Type I and Type II systems (low pressure to 600 PSI).

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Phase Angle Voltmeter Fills Many *Atlas* Needs

A multi-functional Phase Angle Voltmeter, designed and manufactured by **North Atlantic Industries, Inc.** fulfills a prime function in the *Atlas* program. This unique instrument, designed also for phase-sensitive null indication, as a ratiometer for zeroing and testing precision synchros, servomechanisms and transducers, is used to align highly critical control equipment in the *Atlas*.

North Atlantic is a prime supplier of high precision phase sensitive voltmeters to the electronics and missile industries for precision nulling and alignment of control systems, direct reading of in-phase and quadrature voltages, phase angles plus a wide range of other applications in diversified fields.

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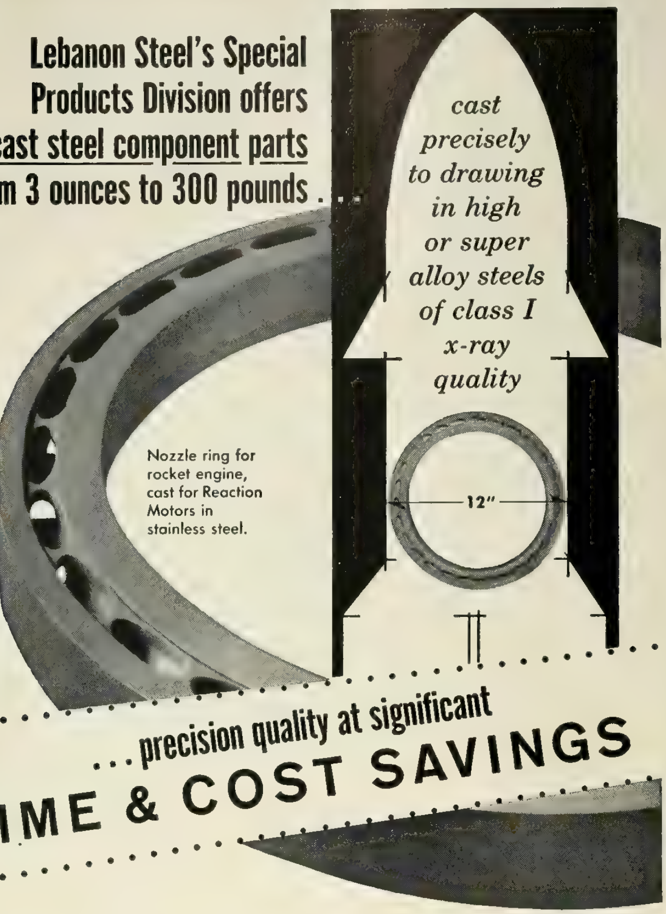
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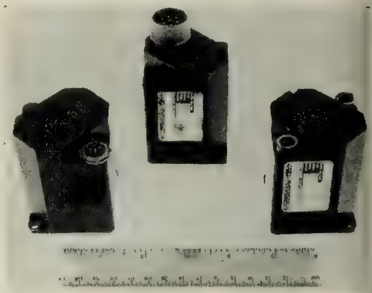
Floated Rate Gyros Withstand Heavy Shock



Floated rate gyroscopes capable of withstanding 150 g shock or acceleration are being built by the **Garrett Corporation's** AiResearch manufacturing division, Phoenix, Arizona.

The rugged units, designed for maximum versatility, operate from either direct, or one, two or three phase alternating current. Regulated or unregulated voltage from 350 to 2500 cycles per second can be used for the AC power supply.

The 210 Series gyros are of completely floated gimbal construction. Damping is held nearly constant over an ambient operating range of minus 67° to plus 165°F. This is accomplished by use of silicone oil flotation together with a special variable gap ring and cam design, rather than with vibration-prone rate springs.

A typical gyro weighs less than a pound and measures 2 1/8 inches square by 3½ inches long. With extreme accuracy the unit will withstand sustained 75 g acceleration in any axis and absorb twice that force without damage.

Under severe environmental conditions, operating life of the new AiResearch gyros ranges from slightly over 150 hours for the DC units to more than 1000 for the AC models.

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Tantalum Capacitors Provide Broad Range

A new line of tantalum capacitors made by **P. R. Mallory & Co. Inc.,** designated the TAP2 series, provides a broad range of ratings.

Only 0.226" in diameter and 0.625" long, the TAP2 capacitors come in ratings covering the range from 140 mfd., 6 VDC to 11mfd., 90 VDC. They are rated for ambient temperatures from –55° to +85°C, and will meet the 2000 cycle, 20G vibration requirements of specification MIL-C-3965B.

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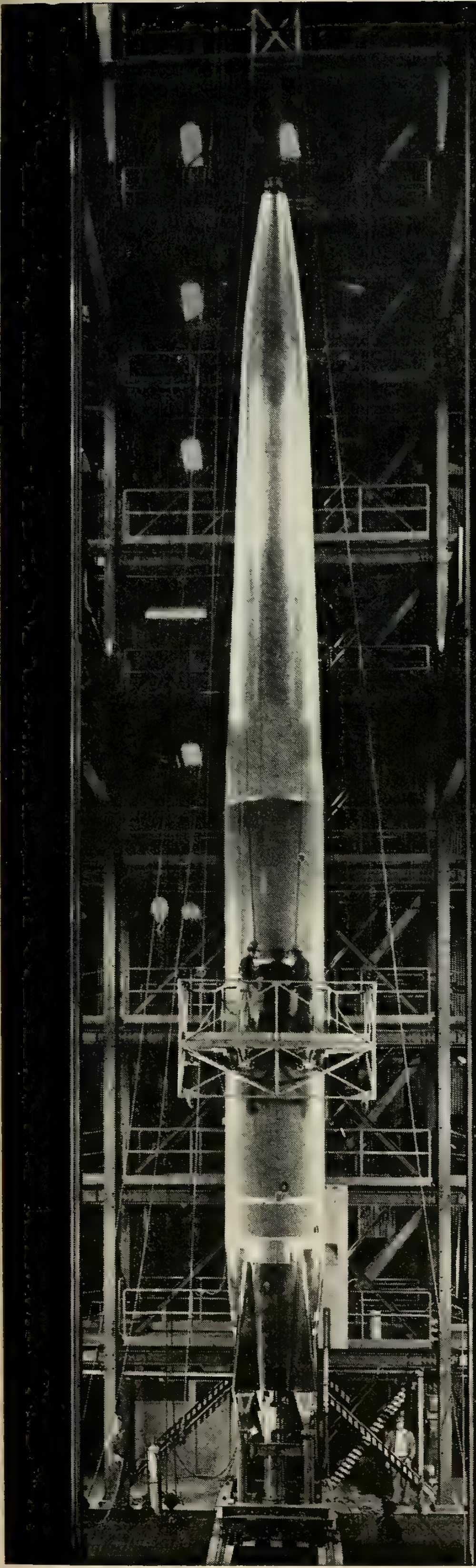

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Take our 100-foot test tower. With it we can simulate the pressure and aerodynamic loadings that occur during the actual launching and flight of a missile.

This is just one of the many specialized facilities and tools that we have built up in the last ten years. During this decade—because of our complete responsibility for the development of a major weapon system—we have also piled up a wealth of experience in many related fields.

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For example, we can simulate aerodynamic heating and loading at the same time...on a complete wing or a large section of fuselage. We're old hands at applying heat gradients from leading to trailing edge and spanwise. And we are equipped to compute temperature differentials, and to predict specific area temperatures.

We're completely qualified to work with any kind of metals or nonmetals; materials and processes; electrical, hydraulic and pneumatic components and systems; structures; reliability; environmental testing (including re-entry); and instrumentation.

Now we'd like to solve your problems. The tougher the better.

Please write to E. R. Schenkel, Missile Division Test Lab Manager, North American Aviation, 12214 Lakewood Blvd., Downey, Calif.

MISSILE DEVELOPMENT DIVISION

North American Aviation, Inc.

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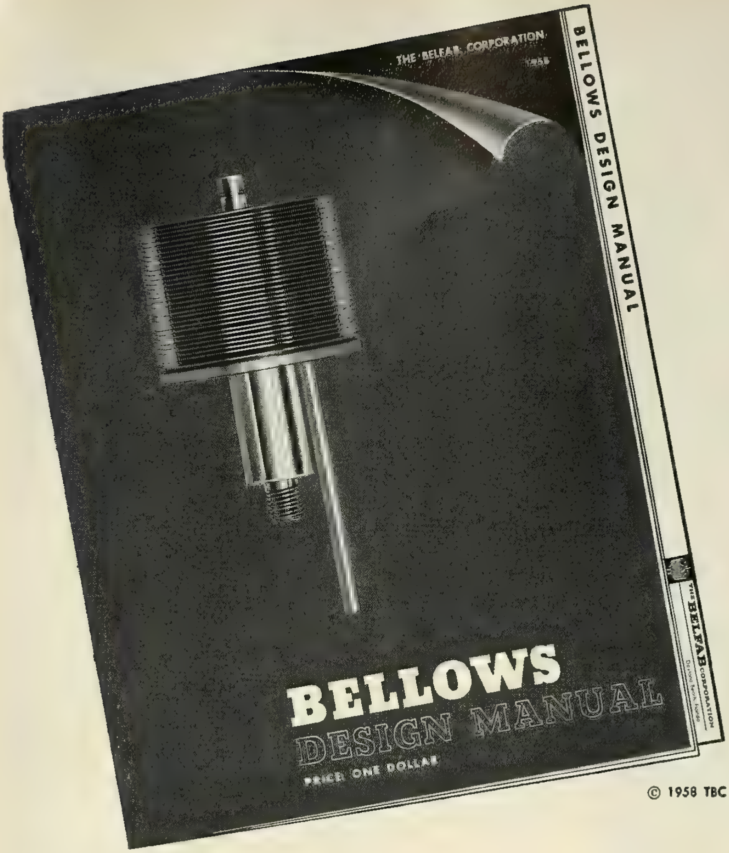

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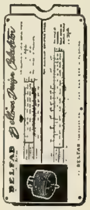
a basic discussion of bellows design criteria including a slide calculator to provide a short cut to approximate bellows design. Made available by the The Belfab Corporation — the leader in the field of precision welded bellows. Price, one dollar.



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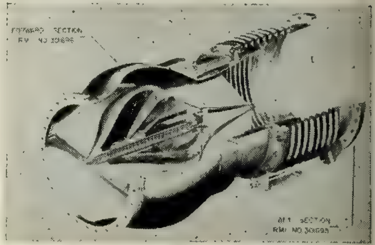
Check-Disconnect Unit Has High Flow Rate



A combination check valve and quick-disconnect unit for cryogenic (–300°F), corrosive or conventional fluid service, has high flow rates, up to 6,500 GPM of liquid oxygen at 70 psi. Maximum pressure drop, through three and a half foot unit length, is less than 4 psi, and has been developed by **Reaction Motors** division of Thiokol.

Extreme light weight results from use of brazed and welded, spun sheet metal construction. The largest current unit, 11-inch line size, weighs less than 50 lb.

The fore section can be used alone as a check valve. In certain applications fluid flows in either direction and the check valve comes into play only after valve and nozzle sections have separated.

This flight qualified item meets rigid leakage requirements for critical missile applications. Special features can be incorporated into the valve to meet operational requirements. Other size units can be provided.

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Cavity Filter Covers Wide Frequency Range

A cast-aluminum Tunable UHF Cavity Filter has been developed by **Adams-Russell Company, Inc.** of Cambridge, Mass. The filter is silver plated for low loss and pressure-tight to prevent the entrance of moisture and dust.

The Model 210 covers the frequency range of 200-420 Mc and has a power rating of 300 watts C.W. This filter provides: reduced interference between adjacent transmitter-receivers operating in same location; preselection for receivers with reduced images and other spurious responses; reduced harmonic radiation from transmitters, (40 db typical for second harmonic); and the capability to multiplex several receivers or transmitters into a common antenna.

Specifications include: Insertion Loss: Approx. 0.5 db; "Q" Factor: Approx. 150; VSWR 1.3.

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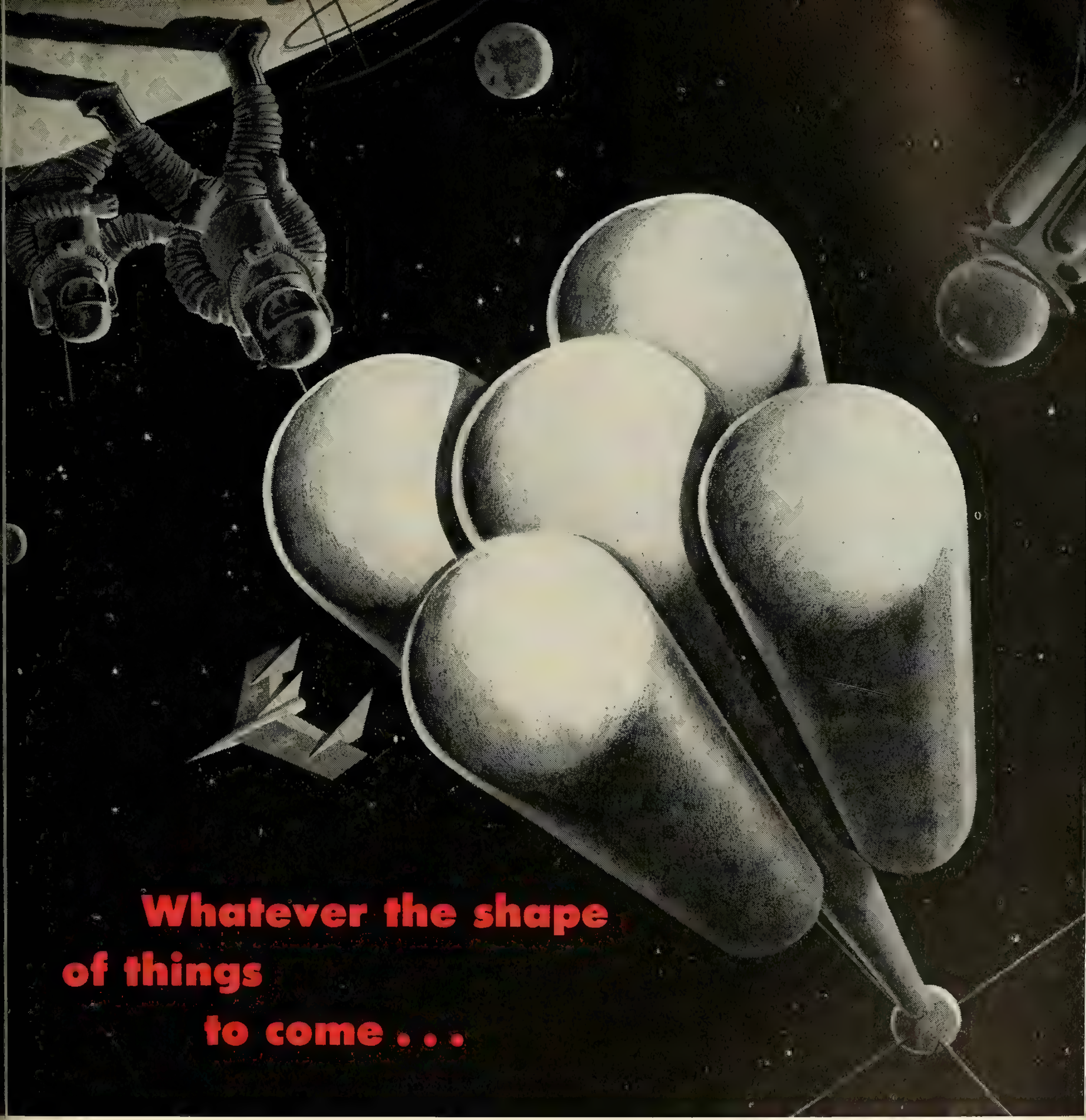

58-16

Fantastic shapes for the space vehicles of the future already are on the boards. Even more radical designs are taking form in the minds of engineers. And their parts and components will just as radically differ from those produced today. New standards of precision and new methods of working new materials will be required.

One thing at least is certain: the same design, development and manufacturing experience which made the transition from aircraft piston engines to jets will be needed to produce these shapes of the future. Since the early 1920's, Ex-Cell-O has been among the major suppliers of machines, parts and assemblies to the aircraft industry. In that time it has built a reputation for extending the frontiers of precision.

Today, Ex-Cell-O manufactures such components as: rotors, blades, fuel nozzles, actuators, valves and fuel controls. Tomorrow? Well, perhaps you yourself have a problem which Ex-Cell-O's long experience in the production of precision controls and assemblies might help you solve. If so, why not contact Ex-Cell-O today?

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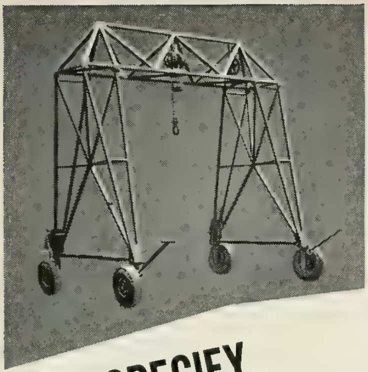

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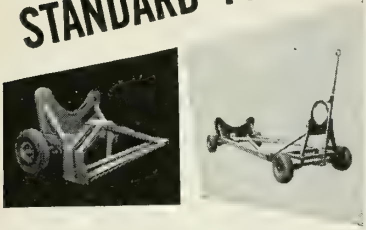

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soviet affairs

by Dr. Albert Parry

While Soviet scientists on the whole are friendly toward their American counterparts, the Soviet government doesn't like this warm interest. Khrushchev is rather suspicious of the pro-Western feelings sometimes displayed by Russian experts of astrophysics and astronautics.

To make sure that Red rocketry will not become a nest of opposition to the Communist Party through too much fraternization with the West, Khrushchev resorts to some noteworthy measures. Increasingly he puts into Russia's rocket and missile laboratories young men from the families of his most trusted Communist henchmen. Recently Khrushchev revealed that he placed his own young son to work in Russian rocketry.

Khrushchev also tries to counteract his scientists' friendly attitude toward Western scientists by ordering his press to keep up attacks against the latter. Typical of such stepped-up onslaughts is an article in the Moscow TRUD by Y. Kornilov aimed at Andrew G. Haley, President of International Astronautics Federation and his alleged remarks on efforts to shoot rockets to the moon.

Kornilov quotes Haley as saying: "Guard the moon! Otherwise the Russians will surely try to annex that unprotected planet. We know these Reds: yesterday it was rockets with them, today it's *Sputniks,* but tomorrow —look out!—they will land their agitators on the moon . . ."

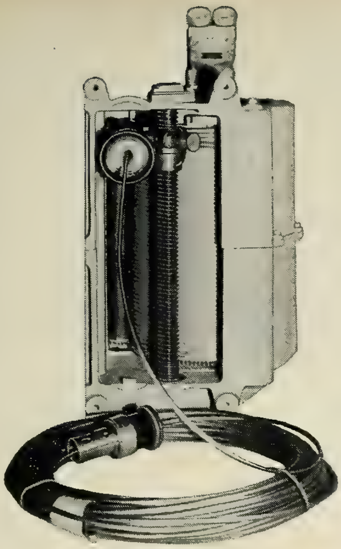
Haley is further quoted by the writer as declaring that should Russia hurl a rocket to the moon and use this as her basis for territorial claims, international tensions would greatly increase and "he would be glad if the Russians would specifically assure him that they have no claims on the moon's territory."

The Moscow journalist asks this question: "Why is Mr. Haley so worried about the fate of that distant planet?" Kornilov solves his own puzzle:

"The reasons are plain. Time was when Americans noisily advertised their future satellite of the earth. But the first *Sputnik* flew into cosmos from the USSR, not from America. A short while ago much hullabaloo was raised in the USA around a rocket to be launched to the moon. One enterprising firm even organized a sale of lots on the moon—at one dollar per lot. However, Americans have not succeeded in reaching the moon. And now Haley, taught by bitter experience, apparently is worried by the possibility that the lots for which those credulous Americans have already paid their money would wind up in Russian hands . . ."

"Haley and his masters are accustomed to view everything from the standpoint of annexation and expansion. And even when the talk is about the moon, they are interested not so much in science as in the problem of who will be the first to grab the territory of that planet."

The attack in the Moscow TRUD is accompanied by a cartoon showing an American policeman wearing eyeglasses with a sour expression and walking the earth on stilts made of dollar signs while raising his threatening billy against the background of the moon. A sign, hanging from the moon, reads: "It is forbidden to land on the moon." The moon's face has a look of painful dismay at such Yankee "imperialism."



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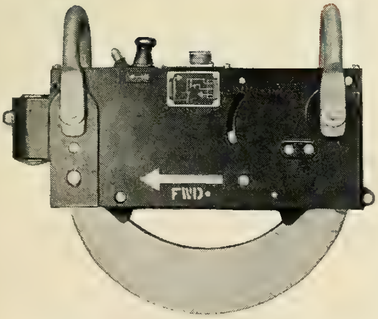
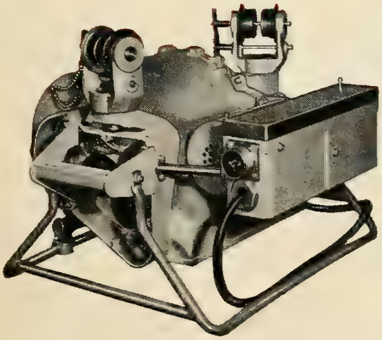


Cargo Hook, 10,000 lb. capacity; 26 volts, D.C. Automatic touchdown feature opens hook to release load at touch; also manual release.



Cargo Winch Assembly, 2,000 lb. capacity; 28 volt electric motor and gear train. Overload clutch; 50 ft. cable, speed 10 ft. per minute.

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Academician Leonid Sedov gave these figures at the Fifth Assembly of the IGY body in Moscow: *Sputnik* I resulted in 60,000 measurements on the basis of radio tracking and 400 measurements based on visual observation. For *Sputnik* II, such measurements were 12,800 and 2,000 respectively; while for *Sputnik* III (up to July 7, 1958) they were 52,750 and 2,000 respectively.

"Super-precise" tracking of *Sputnik* III is being done by the Alma-Ata Mountain Observatory of the Astrophysical Institute of the Soviet Kazakhstan Academy of Sciences, with the aid of what is described by the Russians as a special meniscus telescope of the Maksutov System. It is equipped with a printing chronograph, a special oscillograph, and a quartzitic generator. The resulting photographs fix the *Sputnik* track with an extraordinary exactitude in relation to the stars at each given moment. These photographs are then sent to the Moscow offices of the IGY.

The lifetime predicted by Soviet scientists for *Sputnik* III is not less than 500 days from the day of its launching (May 15, 1958). Its carrier rocket will last about six months from the moment of its orbiting. This compares with 94 days of the existence of *Sputnik* I and the 60 days of its carrier rocket.

Ultra-short radio waves, reflected by meteorite traces, can be utilized for man's radio communications over long distances. So declares A. L. Mints, a corresponding member of the Soviet Academy of Sciences. He maintains that a method of such communication has already been worked out, but admits he does not know how practical it may prove.

He also asserts that, instead of using meteorite-trace radio waves, a radio-wave reflecting "mirror" can be created artificially "high in the sky" by shooting a rocket into the upper reaches of the atmosphere. The rocket, at the highest point of its trajectory, releases—as dust—a quantity of metallic potassium.

The resulting cloud of the thinnest possible powder becomes ionized under the effect of sun rays, and acquires its capacity of reflecting radio waves—thus replacing the meteorite traces. Such a cloud can last 45 minutes and may be used for radio communication for longer periods than without the aid of the artificial "mirror" made by the potassium-sprinkling rocket.

Eight different postage stamps honoring the *Sputniks* have so far been issued by the Soviet government. Pictures of the *Sputniks* have also been placed on Soviet postal envelopes. The Communist governments of East Germany, Czechoslovakia, and Rumania have also honored the Russian *Sputniks* with postage stamps.

The Soviet Union continues its far-flung and feverish search for new minerals and metals to use in the atomic and missile age. P. Y. Antropov, minister of geology and conservation of ores of the USSR, states that this year more than 5,000 scientific expeditions, with a total personnel of nearly 290,000 men and women, are out in the field all over the country engaged in this search.

The future lunar city to be built by the Soviets, once Red rockets reach the Moon, will utilize the Moon's caves rather than its well-known craters. This is stated by Alexander Shternfeld, the celebrated Soviet astrophysicist. He also suggests digging tunnels on the Moon, at the depth of 15 to 18 meters, to reach underground levels where "vacillations of temperature are already insignificant."

Shternfeld proposes protection of such underground lunar cities by a system of inner doors and partitions, also of "tambours," or circular frames, each of two hoops, one fitting into the other. These "tambours" are to be made of sheet iron covered with a coat of silver, and, "yet better—of glass yarn impenetrable by air."

The next *Sputnik* may be the brightest celestial body, next to the Moon. Such are the latest plans of Soviet experts who are working on the ways and means of illuminating *Sputnik* IV when it is launched and orbited, and keeping it brightly lighted for most, if not all, of its existence.

International cooperation of scientists is once again being strongly advocated in the Soviet press. PRAVDA and IZVESTIA have published numerous editorials on the subject, which has been repeated time and again during the IGY and especially during the recent conference in Moscow. The editorials point out that 32 prominent scientists were among those chosen for membership in the Academy of Sciences of the USSR and that 514 delegations of the Academy visited 44 other countries. In addition, during 1957, 139 delega-

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tions of the Academy participated in the work of 62 international congresses.

The relations between scientists of the Soviet Union and "other Socialist countries" and their strong creative friendship are inspiring examples for the scientists of all the world, according to PRAVDA. The Soviet newspapers say that it is not accidental that Moscow was chosen as the site of three great international conferences. The international conference of architects, the regularly scheduled assembly of CSAGI (Special Committee for the International Geophysical Year), and the Tenth International Conference of Astronomers were all held in Moscow.

Photographic observations of Soviet satellites are being carried out in the USSR with the aid of the 50 cm. Maksutov Meniscus telescope, resulting in an accuracy of ±2″ and $0^s.001$ of coordinates and time, respectively. Various methods of making such observations of satellites were tested at the mountain observatory of the Astrophysics Institute of the Academy of Sciences of the Kazakh Soviet Socialist Republic.

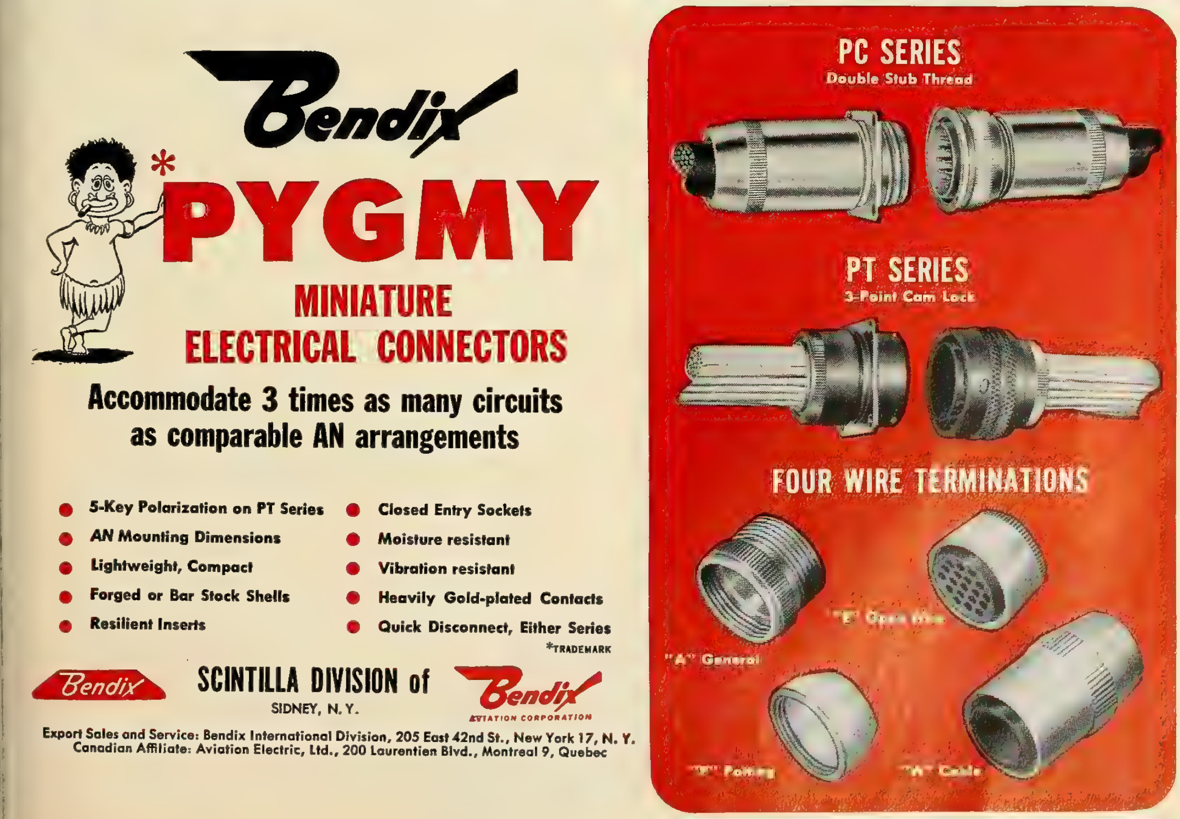
A small, wide-angle, fast camera is used for the purpose, including a camera with a "Sapphire Boyet" objective which was used for observing the carrier rocket of *Sputnik* I. More attention has been given, however, to the organization of more accurate *Sputnik* observations by means of an adequately equipped meniscus telescope of Maksutov design (D=50 cm, F=120 cm).

The Purple Mountain Astronomical Observatory, located on a mountain a few miles east of Nanking, China, houses the largest telescope presently used in China. Situated 875 feet above sea level, the observatory has at least four domes, the largest being a little over 26 feet in diameter. The Red Chinese government claims that prior to "liberation", there were only ten workers at this observatory. Now there are more than a hundred. Facilities of the installation include an astronomical clock accurate to thousandths of a second; an observatory without a dome, but with a long narrow roof opening on a north-south line for observing star transits of the meridian; and electrically operated calculating machines.

Three types of propulsion have been advanced by Soviet scientists as the only practicable methods for creating thrust in outer space. According to R. G. Perelman, Candidate of Technical Sciences, these systems are Ion, Nuclear and Quantum. Ion rockets are stated to be best, and credit for their creation is given to K. E. Tsiolkovsky.

Satellite computing equipment has been the center of recent enigmas concerning Soviet capabilities in this field. Dr. Fred Whipple, head of the Smithsonian Astrophysical Observatory at Cambridge, was reportedly quite annoyed at Soviet failure to release any information on their tracking and computing methods. The Soviet scientists with whom Whipple dealt were even reluctant to explain why the American delegation could not see any of the equipment or installations. There never has been any real information available on the methods used. General statements are available, such as that dealing with telescopes, but nothing on computing equipment.

It may be recalled that very soon after the launching of *Sputnik* I last October, there were announcements from Moscow giving the exact time and location where the satellite could be seen in various parts of the world. Such a rapid and precise system was thought to be almost impossible and not within the capability of the USSR, the only alternative suggestion being that the Soviets were so sure of their launching vehicle that they computed all the data in advance.



Bendix

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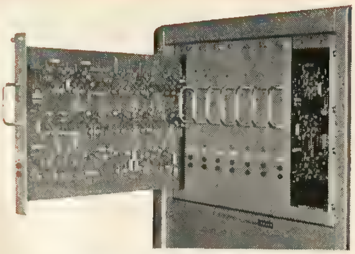

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When and Where

OCTOBER

Sixth Annual USAF Weapons Competition, Interceptor Phase, Air Defense Command, Tyndall, AFB, Fla., Oct. 20-30.

University of California, Aviation Medicine Meeting, UCLA, Los Angeles, Oct. 22-24.

Fourth Annual Symposium on Aviation Medicine, Miramar Hotel, Santa Monica, Calif., Oct. 22-24.

Fifth National Vacuum Symposium, Sir Francis Drake Hotel, San Francisco, Calif., Oct. 22-24.

1958 National Simulation Conference, sponsored by Institute of Radio Engineers Professional Group on Electronic Computers, Statler-Hilton Hotel, Dallas, Texas, Oct. 23-25.

SAMA Laboratory Apparatus and Optical Sections' Midyear Meeting, Westchester Country Club, Rye, N.Y., Oct 26-28.

Institute of Radio Engineers East Coast Conference, Aeronautical and Navigational Electronics, Lord Baltimore Hotel, Baltimore, Md., Oct. 27-28.

1958 National Metal Exposition and Congress, American Society for Metals, Public Auditorium, Cleveland, Ohio, Oct. 27-31.

Armour Research Foundation, Illinois Institute of Technology, 5th Annual Computer Applications Symposium, Oct. 29-30.

IRE, 1958 Electronic Devices Meeting, Shoreham Hotel, Washington, D.C., Oct. 30-31.

NOVEMBER

Fifth Annual Meeting, Institute of Radio Engineers Professional Group on Nuclear Science, Villa Hotel, San Mateo, Calif., Nov. 6-7.

School of Aviation Medicine, International Conference, Physics and Medicine of the Atmosphere and Space, Hilton Hotel, San Antonio, Texas, Nov. 10-12.

1958 Annual Meeting, Society for Experimental Stress Analysis, Hotel Sheraton-Ten Eyck, Albany, N.Y., Nov. 12-14.

Conference on Scientific Information, AFOSR/Directorate of Research Communication, NAS, NSF and the American Documentation Institute, Mayflower Hotel, Washington, D.C., Nov. 16-21.

American Society for Quality Conference, Sixth Annual Aircraft and Missile Division Conference, Biltmore Hotel, Dayton, Ohio, Nov. 17-18.

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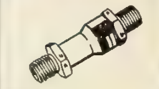

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Thompson—Ramo Merger OK'd STL Remains as Separate Group

by Raymond M. Nolan

Thompson Products stockholders in a special meeting in Cleveland voted to approve the merger with Ramo-Wooldridge by the overwhelming majority of 600 to 1. 99.8% of the 2,216,000 shares of the Thompson common stock voted in favor. Total stock outstanding is 2,764,639 shares. Ramo-Wooldridge shareholders, meeting in Los Angeles, approved the merger unanimously. Space Technology Laboratories, presently an autonomous division of Ramo-Wooldridge, becomes a separate subsidiary corporation with complete operational independence on November 1st.

In a foreword to the proxy statement sent to shareholders, Fred C. Crawford, retiring chairman of the board, said, "The company (Thompson) participated in the organization of Ramo-Wooldridge in 1953 and since then has supplied most of the financing for it. Thompson presently owns approximately 57½% of the total outstanding common shares of Ramo-Wooldridge; and has options (obtained in 1955 and exercisable at specific periods beginning in 1964) which, upon exercise, would give us approximately 85% of the equity ownership. The faith we had in 1953 in the future of Ramo-Wooldridge has been amply justified since that time and we now have the opportunity of obtaining 100% ownership at a price which we believe is substantially less than the price we would be required to pay in the mid-1960s."

Ramo-Wooldridge, organized in 1953 with financial assistance from Thompson, now employs about 4000 people. Out of the original organization have come Pacific Semiconductors Inc., organized in 1954, Space Technology Labs, civilian managers of the USAF ballistic missile program, and Thompson-Ramo-Wooldridge Products Company, organized early this year to develop and market the RW-300 process control computer.

Thompson Products, in business since 1900, has about 17,000 employees. Its major area, until the merger, has been as a supplier of components and sub-systems to the aircraft and automotive industries, although they have been moving into the electronic and nuclear fields gradually.

R-W got its start when Dean Wooldridge and Simon Ramo, then vice presidents of Hughes Aircraft, obtained financing from Thompson Products in exchange for 49% of the new company's stock. Their original 1000 foot building (now a barber shop) in Los Angeles has grown to a total of 17 buildings with 987,300 sq. ft. of which 585,900 sq. ft. are located in the company's partially completed electronics complex on a 41-acre site south of Los Angeles International Airport. When the complex is completed in 1959, it will total some 850,000 sq. ft.

The merger results in a fairly impressive sales picture for the new corporation. When it becomes effective on October 31st, TRW will have over 20,000 employees, assets of more than $200 million, and estimated sales for 1958, "somewhere between $300 and $325 million" according to a Thompson spokesman.

One problem which could have become thornier has been solved by the formation of Space Technology Labs as a separate corporation. Mr. E. C. Jones, secretary of Thompson Products, in a special notice to stockholders, said, "Because of the special nature of its participation in the ballistic missile program of the Air Force, Ramo-Wooldridge has, in effect, been excluded from the fabrication of equipment for use in the *Atlas*, *Titan* and *Thor* production missiles planned for the Air Force weapons inventory. While the proposed merger might result in an application of this type of exclusion to manufacturing activities of the company, Ramo-Wooldridge has presented to the AF and is presently engaged in a program for the separation of the activities of Space Technology Labs (STL) which, it is expected, will permit the merged company to compete for production contracts in the AF ballistic missile and space weapons programs."

STL will become a separate corporation on November 1st with a majority of its directors persons not connected with the Thompson Ramo-Wooldridge group. General James H. Doolittle will become board chairman on January 1st. All of the announcements to date have stressed the fact that the parent corporation will have no hand in STL's policies because of its involvement in the ballistic missile program.

In the merged group, J. D. Wright, now Thompson's president, becomes Board Chairman and Chief Executive Officer. Fred Crawford, present chairman of the board will retire but will continue as a director and head of the executive committee and will be retained as a consultant (at $85,000 yearly) to the company. Dr. Dean Wooldridge, now president and a director of R-W, will become president of the merged company, and Dr. Simon Ramo, now a vice-president and a director of R-W, will become executive vice-president.

A number of rumors which have been circulating about the merger were scotched by Thompson's Operations Vice-President Horace Shepard (who will become assistant to the Board Chairman in the merged company.) One report, Mr. Shepard said, was that Mr. Wright would be less active in the company. He pointed out in answer to this that Mr. Wright's significant title is that of chief executive officer and as such he will be as active as he has been.

Another rumor—that Thompson would go out of the auto business—was dismissed as ridiculous by Mr. Shepard. Nor is there any truth, he said, in a report that the new corporation may consider closing its Cleveland plants.

In a talk before a Thompson group recently, Dr. Wooldridge said that the merger is being made from a position of strength with the resulting organization designed to tackle military and commercial systems that neither Thompson or Ramo-Wooldridge could have handled separately. He also stated that there is no intention of interfering with the lines of activity of either company.

36-Inch 'Scope To Probe Space From Balloon

WASHINGTON—Plans for a 36-inch telescope to be sent to more than 80,000 feet by unmanned balloon to photograph planets, nebulae and galaxies has been announced by the National Science Foundation and the Office of Naval Research, joint project sponsors.

Called Stratoscope II, the telescope is a continuation of the ONR-backed 12-inch Stratoscope I telescope flown last fall to photograph the sun (m/r, June 1958, p. 73).

Dr. Martin Schwarzschild of Princeton University's Department of Astronomy will direct the Stratoscope II project, and the continued use of the Stratoscope I sun telescope.

The 36-inch telescope—currently the subject of a design study by the Perkin-Elmer Corp., Norwalk, Conn., which designed and built the Stratoscope I telescope—will have a television link with the ground.

The first flight of Stratoscop II is scheduled for 1961.

Inflated, Painted Sphere Ideal For Testing Radiation Belt

• Scientist Suggests New Methods That could Also Improve Sphere Visibility

by Peer Fossen

Exploration of the van Allen Belt by deliberately releasing large quantities of gas in the belt and observing the rate of expansion of the glowing gas cloud was proposed by German scientist Savo Coric in the July 14 issue of m/r. Since then, *Explorer* IV has been successfully launched, and its payload immediately revealed a series of secrets of great value to space technologists.

The recent Lunar Probe carried with it radiation measuring instrumentation to an altitude of approximately 80,000 miles, and the scientists have reported that preliminary findings indicate the van Allen Belt is less serious than expected from the standpoint of future space travel.

The telemetered findings of the probe showed that activity was at a rate of four Roentgens per hour at 5,000 miles, three Roentgens per hour at 10,000 miles and two Roentgens per hour at 17,000 miles. It is calculated that had a human being been aboard the rocket in its ascent, the space traveler would have suffered less than 50 Roentgens of radiations. The lethal dose is about 450 Roentgens.

Answers to these and other related questions will undoubtedly come from the lunar probes, but it is uncertain whether the lunar probes alone can explore all the secrets of the radiation zone.

• Army Project Best Bet For Exploring Belt

In the opinion of scientist Coric, there is one existing U.S. satellite project which, if properly adapted, could be instrumental in revealing further secrets of the radiation belt.

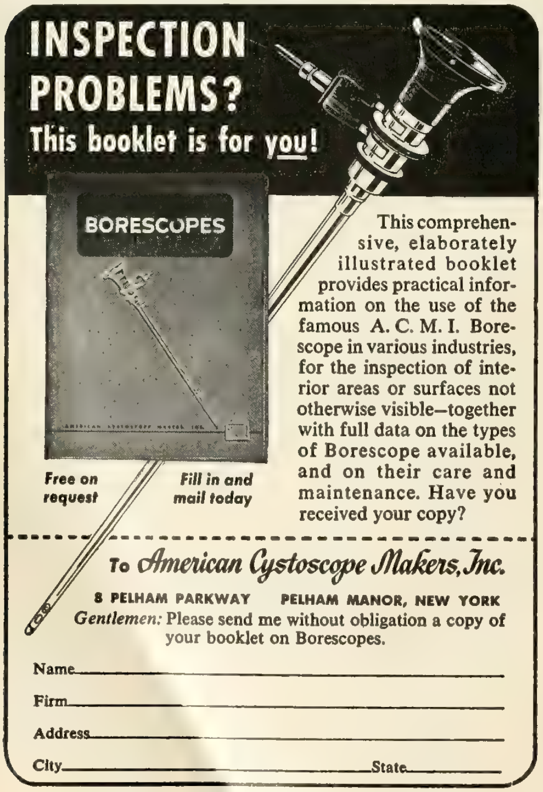
The project referred to by Coric is the Army's plan to place a balloon-like satellite in orbit to determine the air density in the upper regions of the Earth's atmosphere. A large inflated plastic sphere would be used for the tests.

Such a sphere is particularly well suited to carry out air-density measurements in the extremely tenuous atmosphere it would encounter in the lower parts of its orbit. It has a large surface-to-mass ratio, which means it will experience a much larger air drag than a smaller and denser metallic satellite.

This in turn will result in a correspondingly rapid descent to lower altitudes, where the balloon will finally be destroyed by the air friction in the denser atmosphere. The sphere's rate of descent, determined by means of optical tracking, will make it possible to compute the air density along the lower part of the orbit.

Coric's suggestion is that this balloon-like satellite be given a second task to perform; exploration of the radiation belt.

Along the higher part of the orbit, it will hardly encounter air molecules, but more and more charged particles of the radiation zone. What these particles are and how they behave in space is still a subject of conflicting theories but it seems certain that there are currents of charged particles around th earth whose fluctuations seem to b responsible for the perturbations of th earth magnetic field one or two day after a period of increased activity o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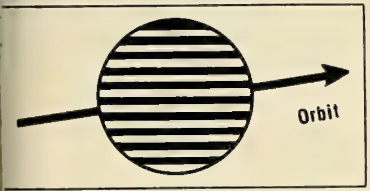
sun spots. If such currents cross the orbit of the balloon, they will be detected and their intensity and course determined by means of the observed deviation of the satellite's orbit.

When these currents are mapped, other satellites, or research rockets, equipped with radiation counters could be sent to record the fluctuations of the intensity of currents after an increased activity of sun spots has been observed. At the same time, other apparatus at the ground stations would record the fluctuations of the earth's magnetic field induced by the fluctuations of the charged-particle current. By comparing the fluctuation curve of the earth magnetic field with the fluctuation curve of the charged-particle current, the course of the current being known, the nature of the charged particles—protons or electrons—could easily be determined.

Larger fluctuations in intensity of a charged-particle current could, according to Coric, be detected by the balloon itself, but it would be a pure chance because the balloon-satellite has a very short life-time.

• Stripes on balloon will lengthen its visibility



The outer surface of the balloon is o be covered by a reflecting paint so ne balloon can be optically tracked at awn and dusk when the satellite is atching sun rays, while the observing ations are still (or already) in the ark. The time during which a satellite visible in passing over a tracking staon is very short (a few minutes), and nis is a serious drawback for a satelte whose lifetime is short.

However, Coric has come up with very simple trick to lengthen—to a onsiderable extent—the time of visiility of this satellite. It involves coving only one half of the outer surface the balloon with painted circular ripes separated by stripes of unainted satellite's skin, as shown in the ove sketch.

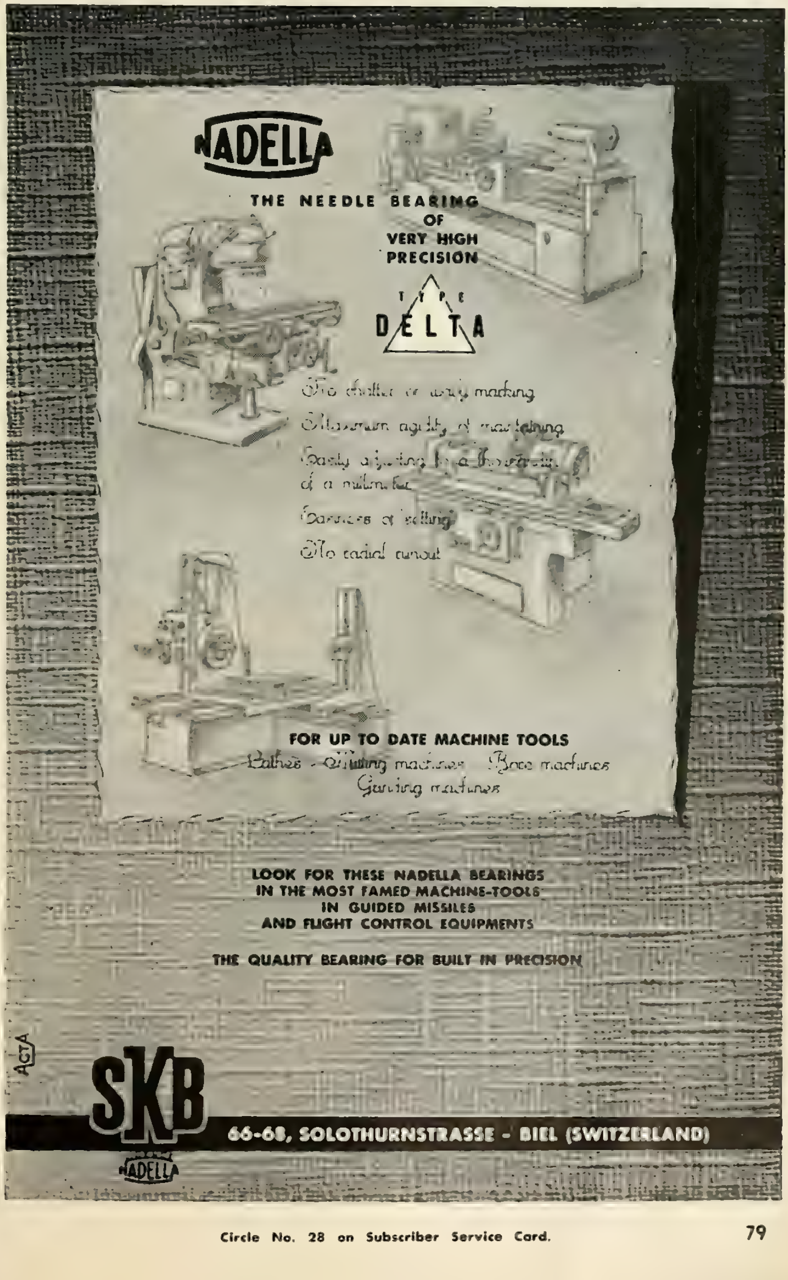
When the painted satellite is ciring through the radiation belt, the arged particles will bombard it and, ing energetic enough, penetrate its in skin. Inside the satellite they will cite and ionize the filling gas which ill glow in its characteristic color, and this glow will be visible from the earth through the unpainted transparent portions of the balloon. By this method, tracking of the balloon will be possible both when it is catching sun rays and when it is orbiting in the shadow of the earth.

The balloon will naturally lose some of its reflectivity after it is painted. The loss, however, will be less than 50% since some of the sun rays penetrating into the balloon through the unpainted stripes will be reflected from the back surfaces of the painted stripes and caught by the ground stations. In Coric's opinion this is no serious handicap for a large satellite, and the benefit of prolonged tracking time will far outweigh the loss of reflectivity.

An alternate method is to use painted spots instead of the painted stripes.

• NASA Project Could Also Benefit From Method

Coric also visualizes that another U.S. project can benefit from the prolonged tracking time obtainable in the above-mentioned manner. Here, he has reference to the 100-ft.-diameter balloon-like satellite NASA plans to put in orbit next year. The purpose of the satellite is to study the possibility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of using huge electric-wave-reflecting spheres in space to reflect back to earth the electric waves directed to them from radio, TV and radar transmitting stations in an attempt to greatly extend the range of these stations.

The electrical reflectivity of such a balloon would hardly be affected by the fact that only one half of the balloon's outer surface is covered by reflecting metallic paint. In effect, the electric waves are much longer than the light waves, so they would not penetrate through the narrow unpainted stripes into the interior of the balloon. If they did, they would be reflected because the ionized gas is a good electric-wave reflector.

Westinghouse Discovers New Chemical Compounds

Scientists of Westinghouse Research Laboratory, Pittsburgh, have discovered a new "family" of chemical compounds which promise to be among the most unusual in science. The alloys use uranium, molybdenum and other metals. Electrical currents flow in them undiminished and apparently forever.

Dr. J. K. Hulm, manager of the laboratory's solid state physics department said, "Because of uranium's widespread application as a nuclear fuel, the metallurgy of uranium and its alloys has been extensively explored. But no comparable research has been carried out on the electrical properties of these materials. Our purpose was to study the unique electrical resistance of uranium alloys down to very low temperatures and to continue a basic investigation of superconductivity that has been pursued in these laboratories for many years."

Measurements of resistance were made on uranium-molybdenum and uranium-niobium alloys that had been stabilized in crystal structure by heating to 1650 degrees F for 24 hours and subjecting them to rapid quenching in water.

Contrary to all known alloys, the electrical resistance of the uranium alloys became progressively larger as the temperature was decreased down to one or two degrees above absolute zero. Then they suddenly became superconductors. The superconductivity was surprising to the Westinghouse scientists because of the rise in resistance preceding it.

The next compounds studied by Dr Hulm and his associates were a group of intermatallics using uranium with such metals as aluminum, manganese iron, cobalt and nickel. These were the studies which led to the discovery of the new superconductors.

The four superconductors were among the intermetallic compounds Two of these were the first reportedly ever known to contain manganese and iron. Since the presence of these elements has always been regarded as undesirable to superconductivity, the Westinghouse group may have turned up a development of future usefulness.

Superconductors such as these could cause a revolution in the electronic and electrical industries if the operating temperatures could be raised to more easily attainable values. This would make sub-miniature electronics device for missiles and space vehicles a reality, since the amounts of current required for operation would be so muc smaller.

Closed-Circuit TV Used For Missile Instruction

The U.S. Army Ordnance Guide Missile School at Huntsville, has begu telecasting a two-hour closed-circu course in maintenance of Army mi siles to the U.S. Army Armor Scho at Fort Knox, Ky.

Instruction covers the *Nike-Aja* *Nike-Hercules*, *Corporal*, *Lacross* *Hawk* and *Redstone*. The course which will enable the two training ce ters to share equipment and instructor will run through next June on the fir three Wednesdays of each month, was announced.

The Army said that the techniq could also make available for instru tion purposes the school's missiles a equipment valued at $100 million.

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Hughes Develops 3-D Radar for Air Defense

WASHINGTON—The development of a new "three-dimentional" radar—called Frescanar—capable of detecting airborne targets at extreme ranges and simultaneously computing distance, bearing, and altitude has been announced by the Department of the Army. According to Army spokesmen, this is the first time simultaneous computation of range, bearing, and altitude has been accomplished.

The new radar and its associated electronic system is considered one of the most remarkable advances made in the field of electronic detection since the development of radar. Developed for the Army by Hughes Aircraft Company, Fullerton, Calif. the new radar will function as the eyes of *"Missile Monitor,"* a mobile Army air defense guided missile fire distribution system. The radar itself was originally devel- pped by Hughes for shipboard use by he Navy.

In comparing the new "3-D" sys- em with conventional radars, the Army points out the following ad- vantages:

1. Range performance. By concen- rating all available power in sharp encil beams, Frescanar pinpoints tar- ets at great distance with extreme ccuracy.

2. Single antenna and operator. Conventional systems need two or nore radars, operators, and master onsoles for comparable results.

3. Triple function by simultaneous omputation of range, bearing and ltitude.

4. Greater speed. All three types f data are transmitted to missile bat- eries, helping them to direct missiles t targets more rapidly.

5. Sees more targets clearer. Elec- ronic beam scans rapidly and greatly ncreases number of targets which can e tracked at the same time. This pro- ides better separation of closely spaced rgets with minimum of ground utter, and pinpoints targets faster.

The mobile system consists basic- lly of an equipment van housing all dar gear with exception of the an- nna, a power truck, and an antenna ailer.

All units of the system—which will ovide information needed to fire issiles such as *Nike-Hercules, Nike- jax* or *Hawk* at airborne targets— e interconnected and can communi- te with each other even though a rtion of the system may be destroyed inoperative. Thus a fragmented stem still could operate effectively. e group commander at each weap- s' monitoring center has complete formation on all aircraft in his area.

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August Transistor Sales High

WASHINGTON—After the slight decline in the transistor market in July, Electronic Industries Association reports that factory sales of transistors in August attained the highest level in the history of the solid state industry. With 4.226 million units sold in August, the total number of transistors sold during the first eight months of 1958 is brought up to 25.310 million. In comparison, sales recorded by EIA for the entire year 1957 amounted to 28.738 million units.

The following chart, prepared by EIA, shows factory sales and dollar values of transistors for the January-August period of 1958. The unit figures for the corresponding months in 1957 are included for comparison purposes. The 14.611 million units sold during the first eight months of last year had a total value of $42,063,000.

	1958 Sales (units)	1958 Sales (dollars)	1957 Sales (units)
January	2,955,247	$ 6,704,383	1,436,000
February	3,106,708	6,806,562	1,785,300
March	2,976,843	6,795,427	1,904,000
April	2,856,234	7,025,547	1,774,000
May	2,999,198	7,250,824	2,055,000
June	3,558,094	8,232,343	2,245,000
July	2,631,894	6,598,762	1,703,000
August	4,226,616	9,975,935	2,709,000
TOTAL	25,310,834	$59,419,783	14,611,300

These figures lend themselves to some interesting observations pointing out the continuing downward trend in transistor prices. The unit and dollar totals for the first eight-month period of both 1957 and 1958 show the following increases over a one year period:

	Units sold	Dollar value
Jan.-Aug. 1958	25,310,834	59,419,783—
Jan.-Aug. 1957	14,611,300	42,063,000—
Increase	10,699,534	17,356,783—

On a percentage basis, this means a 70% increase in number of units sold, while the dollar volume was increased only by a factor of roughly 40%. The average price per unit from factory in the January-August period of 1957 was close to $2.60. The figures for the same period in 1958 leaves a unit price of $2.35, indicating an average drop of $0.25 per unit.

Unit costs will continue to decrease for quite a while yet. With most of the initial research and development money already absorbed, the semiconductor industry foresees that mechanized production techniques, plus development of new devices, will significantly lower manufacturing and production costs within the next decade, and that the realized savings will be passed on to the customer. The full impact of modern mechanization is expected to be felt in 1965. This, along with device developments such as the glass transistor—already built in developmental quantities by some manufacturers—will put the industry in a position to lower the average germanium transistor unit price, to a point where it is directly competitive cost-wise with vacuum tubes. Silicon transistor prices are also expected to continue the downward trend as manufacturing economies are realized.

The transistor business which grew from nothing in 1952 to nearly 30 million sold units in 1957 is expected to market 100 million units in 1965.

Ball Bearing Retainer Gives Long Lubrication

A new ball bearing retainer, developed by the Barden Corporation of Danbury, Conn., and called NYSORB, minimizes oil mass shifts and provides long-time lubrication.

The retainer is sintered from a finely divided nylon powder and impregnated under vacuum with an instrument oil. Since the oil is evenly distributed, there is little mass shift. The unit retains 20 to 25% of its own weight of oil under accelerations of over 800 g's.

The generally severe preload, speed, and environmental conditions present in missile gyro applications make the problem of lubricant mass shift an annoying one. Navigational errors are introduced which must be either tolerated or compensated.

Barden claims that many bearings with oil-impregnated NYSORB retainers as their only lubricant have operated within specifications for more than 5000 hours under extreme preload and speed conditions. In the same tests, bearings using conventional phenolic retainers had an effective life of only 200 hours. The new retainers absorb 10 to 20 times as much oil.

RCA Gets $3 Million Semiconductor Contract

Two USAF contracts totaling $3 million have been awarded to RCA by AMC and Wright Air Development Center, for the development of high-temperature devices using gallium arsenide and indium phosphide.

The contracts call for the development and production refinement of a computer diode, and power rectifier, a general-purpose transistor and a power transistor. The main requirements for each unit are that it will be capable of operation at 400 degrees Centigrade and that the case will be able to withstand temperature of 600 degrees Centigrade. One rectifier already developed by RCA operates at 350°C.

"Gallium arsenide and other compound semiconductors," an RCA spokesman said, "possess high temperature characteristics which permit the construction of semiconductor devices that can operate efficiently at temperatures substantially higher than is possible with germanium or silicon units. In addition, the use of these materials in transistors promises to provide the high-temperature advantage of silicon.

A special high-temperature laboratory has been established at the Somerville plant to carry out portions of the Air Force contract and reportedly i capable of furnishing research durin most phases.

Automatic Tool Program Is NAA-AIA Development

A new development, called APT (the automatic programming of tooling), a joint development of North American Aviation and Aircraft Industries Association, will allow the direc and automatic conversion of design intent to tooling or finished parts.

A combination of the three-axis numerical control system NUMILL and the general-purpose, all-transistorized, digital computer RECOMP II—products of Autonetics, a division o North American—slashes the time-spa from design concept to hardware.

On display at the Western Too Show in Shrine Exposition Hall, Lo Angeles, are airfoil sections—template and scribed lines—produced directl and automatically from design intent.

In the new system, an engineer ca feed logical design possibilities into th computer and optimize design, which then converted to mathematical equivalents on tape. From the tape information, NUMILL directs one or man standard machine tools in producin high-precision parts. Tolerances .0002 inch are claimed to be repeatab for the system.

keeping track

by Peer Fossen

One watt of electricity is sufficient to power the transmission of a rough TV-type picture of the moon's far side, according to Dr. Charles Sonnett, head of Applied Physics in the Instrumentation Division at Ramo-Wooldridge's Space Technology Laboratory. Used in conjunction with a 60-ft. receiving paraboloid, the one-watt unit would be able to transmit the picture over the 240,000-mile moon-to-earth distance in about 30 minutes to one hour. Current lunar probe TV instrumentation is believed to have a power demand much higher than one watt.

Once a lunar probe is successfully on its way into space, we must turn to Britain to get part of the answers to two vital questions: "Where is it?" and "How is it doing?" The answers will come from the University of Manchester, or more specifically from its 250-ft. steerable radio telescope at Jodrell Bank. The giant disc—the world's largest—will play a dual role in the moon shot programs; 1) pick up signals relative to the probe's position, and 2) pick up information telemetered back from the probe's instrumentation package.

All data gathered at Jodrell Bank will be forwarded to USA for final reduction and analysis. The Jodrell Bank telescope is of particular value in the tracking of lunar probes, since it has the narrowest beamwidth of all steerable instruments in the world. Should a probe go off course and escape, the telescope is capable of staying with it for a distance of one million miles, provided the batteries powering the transmitters in the probe are still functioning.

The Jodrell Bank telescope will cease to be the "world's largest" when Navy finishes its 400-ft. steerable paraboloid at the Sugar Grove, W. Virginia Naval Radio Research Station. Work on the $60-million giant telescope—to be used in the study of outer space, advanced scientific research on the characteristics of the earth's atmosphere, and geodetic and geomagnetic studies of the earth itself—is anticipated to commence no later than October 15.

This tracking business is as fascinating as it is intricate and accurate. Recently, two Minitrack stations were temporarily out of commission for maintenance purposes. When put back in operation again, they were simply tuned in and locked on the *Vanguard* satellite, saving all the time and effort thrown into the calibration and lining up normally required to place one of these stations in operation.

With the death of the *Explorer* IV transmitter, *Vanguard* is the only U.S. satellite capable of maintaining radio contact. The transmitters in the *Vanguard* sphere are powered by Hoffman Electronics' silicon solar cell batteries.

From Britain come words of considerable progress in the development of photoelectric equipment for long-range detection of infrared radiation. According to Minister of Supply Aubrey Jones, the devices are so sensitive that they can detect immediately the launching of a ballistic missile 1000 miles away. The new devices are as yet not incorporated in a ballistic missile counter-weapons system, but work is being carried out toward this end.

Florida Development Commission's third Business Research Report shows that the state added 296 new industrial plants or major expansions between January 1 and July 31. More than 10,000 new factory jobs were created. Of these, more than 25% were in electronics.

DATA PROCESSING SYSTEM SPECIALISTS

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A missile comes "of age"—reaches operational status—as a result of many influences. Vital among these influences is the rapid incorporation in the test vehicle of modifications required by evaluation of flight performances. The faster these modifications are made, tested, and become incorporated in the design the faster the vehicle is declared operational.

The completion of this cycle is dependent too upon the speed with which vast amounts of test data can be reduced, analyzed, evaluated, and reported to the military and to the cognizant weapon systems contractors.

So, with the advent of missiles has come a revolution in data processing techniques—a revolution in which the Engineering Services of Telecomputing Corporation has been highly successful in greatly reducing the elapsed time for complete processing of missile flight test data.

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North American Rolls Out X-15 For Test Flights

LOS ANGELES—The first X-15 space vehicle has rolled from North American's assembly plant to move into the final phase—flight test—of a program started six years ago for sending man beyond the atmosphere in powered flight.

With completion of the third vehicle, the program is expected to cost $121.5 million in direct contract costs, plus sizeable additional indirect costs. The costs primarily are for laboratory and wind tunnel testing done by the National Aeronautics and Space Agency and the Air Research and Development Command. NASA has supported the program from its operating budget without contributing funds to defray direct contract costs.

With the roll-out of the hybrid air/space craft, additional details of its make-up were made available (m/r, Oct. 6, p. 17). The vehicle was designed around eight major sub-systems and components—engine, propellant system, hydraulic system, primary flight controls, auxiliary power units, ballistic control rockets, landing gear, and air conditioning/pressurization system.

The XLR-99, basic engine for the X-15, will not be delivered until sometime next year. While awaiting the 50-60 k Reaction unit, two RMI-XLR-11 engines (used in earlier X-1 rocket planes) will be utilized for initial flight tests. A single RMI-XLR-11 engine develops approximately 15 k. The 30 k thrust of the two engines is deemed sufficient for the early low apogee ballistic flight paths.

Propellants for the XLR-99 engine are liquid oxygen and ammonia fed at a flow rate of 10,000 pounds per minute. A hydrogen peroxide steam generator will drive a turbine pumping the propellants to manifold pressure. Helium is used for tank pressurization and liquid expulsion.

The horizontal and vertical tail control surfaces, speed brakes, and the landing flaps are operated by two 3,000-psi systems operating in parallel. The primary flight controls are a further development and extension of the conventional aircraft method designed to withstand increased surface loads, high g forces, and extreme temperatures. Above the atmosphere the X-15's controllability will be dependent upon hydrogen peroxide steam jets located in the nose and wingtips. Proper attitude will be maintained during the ballistic trajectory by actuating the jets from a three-axis control system.

Two auxiliary power units, developed by General Electric, operating in parallel will supply electrical and hydraulic power.

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Pentagon Starts Annual Budget Battle Early

The annual struggle within the Pentagon over how much money to request from Congress is well along. The individual services, skirting the official "guidelines" laid down by DOD top echelons, have proposed budget requests running well over the DOD party line recommendations, and threaten to boost the defense budget by about $1 billion for FY 1960.

The reasons for establishing guidelines seem to rest in a concentrated effort to stop a runaway defense budget from mounting to higher and higher figures every year—at the rate of $1-billion jumps.

Although Deputy Defense Secretary Quarles emphasized that the guidelines were not intended to have the effect of ceilings on individual service requests, the Defense Department cannot conceivably overlook wholesale disregard of its recommendations.

Secretary Quarles added that the guidelines were intended to control expenditures, not appropriations, but admitted that there were no plans to change the DOD budget request to Congress. He said that planning was very much in the formulative stage and no final decision have been made. If made necessary by future developments, Quarles said, an alternative budget may be submitted, if a form can be agreed on by all concerned no later than January.

Declining to release information on the amount of excessive requests involved in the controversy, Quarles commented only that the heads of the various services are trying to iron out the situation with top DOD officials.

Secretary Quarles gave an indefinite answer when asked about rumors of cancellation on the B-58 Hustler and the *Titan* ICBM. "I would not like to imply that plans for cancellation are underway," he said.

• **Some Withheld**—When questioned about the billion-dollar fund that Congress supplied for such projects as the *Hounddog, Polaris,* and *Minuteman* Secretary Quarles commented that this money would not be spent "at this time." He noted, however, that this decision may change, depending on future developments.

The individual service heads have consistently held that they cannot maintain their defense programs at levels set by the DOD guidelines. Quarles, stressed that the services are free to request whatever funds they need to support their defense programs for the next fiscal year. The tentative limit, $500 million, on budget increase by DOD planners for this year if accomplished, would be a considerable departure from recent years, which saw the budget increase at a rate of $1.8 billion this year over the previous year.

Aerojet Infrared Tracker Cheaper than Minitrack

AZUSA—A team from Aerojet-General Corporation's Avionics Division recently tracked Soviet's *Sputnik* III using the Aerojet Model S8 infrared tracker. The team, headed by C. E. Dunning brought the equipment up in the San Gabriel Mountains north of Glendora, California where they set up a mobile laboratory.

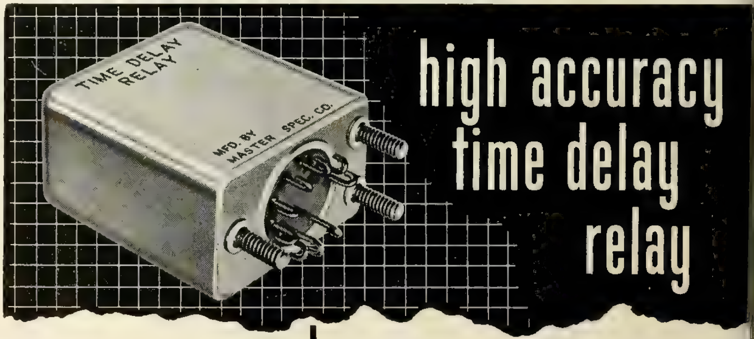
Mounted on a five inch naval gun mount, the infrared tracker is a small instrument—total weight about 20 pounds—with a folded reflecting optical. Measuring only six-inches in diameter, the system has the same basic configuration as the Palomar and Mt. Wilson telescope.

According to company officials, the purpose of the tracking experiment was to obtain radiation characteristics of the satellite. The resulting data are being used to establish the sensitivity and optical requirements for specialized infrared trackers capable of tracking every passage over a monitored area. The data will further be used for continued research into the problem of using infrared instruments for navigation in space.

In an interview with Dr. R. H. McFee, Director of Research for the Avionics Division, m/r learned that work on the S8 infrared tracker was started about two years ago for the Navy. The current equipment, however, is being developed on Aerojet's own funds. Although the device is still considered in the R and D stage, Dr. McFee feels it is abreast of the state of art in the infrared field and that it would result in savings if incorporated in the tracking equipment used by the United States today. As an example, if the infrared tracking device replaced the radar instrumentation of the Minitrack stations, a saving of approximately 20% could be realized. (Price of one Minitrack statio amounts to about $250,000—plus construction and installation.)

Sputnik III was at an altitude o 250 miles above the earth when th Aerojet team successfully proved thei tracker. Maximum range of Aerojet' infrared device is not obtainable.

As reported on page 83, Britai has recently completed a developmen of an infrared device capable of detecting the launching of a ballisti missile at a distance of 1,000 miles.



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Single-Stage Soviet Rocket Reaches 280-Mile Altitude

Vehicle carries dogs and instruments aloft at 3800 MPH to test space cabin design and stabilizing equipment

Sovfotos
Design of Soviet space suit is tested for flexibility at control mockup in USSR.

The Soviet Union launched a second single-stage rocket to altitudes of 280 miles recently, and sent two dogs along as passengers.

The official announcement gave the weight of the "geophysical scientific apparatus, radio telemetering devices, power sources, the hermetic cabin with the experimental animals and auxiliary systems together with the instrument section" as 3725 pounds. As in previous such statements, there was no mention of total vehicle weight or total payload weight. (See m/r, Sept. 15, p. 25.)

The launching was made to test equipment and perform biological experiments on the dogs involved. The Soviets also released a photo (above) of one of their full-pressure space suits.

The announcement stated that the rocket was completely stabilized throughout the entire flight, including the inertial portion. Mention was made of the fact that the cabin involved insures the necessary condition for life at altitudes of 60 to 130 miles. However, the vehicle ascended to a height of 280 miles and there are no details on the equipment performance to that altitude.

According to the official Soviet scientific announcement, the rocket ascended at a velocity of 1.057 miles per second and descended at 1.059 miles per second.

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advertiser's index

AMP Inc. 21
Airborne Accessories Corp. 54
AiResearch Mfg. Co., Div.-The Garrett Corp. 32
Allegheny Ludlum Steel Corp. 53
American Cystoscope Makers, Inc. 78
American Welding & Mfg. Co. 85
Applied Science Corp. of Princeton 44
Avco Mfg. Corp., Research & Advanced Dev. 4
Baldwin-Lima-Hamilton Corp., Standard Steel Works Div. 26
Belfab Corp. 68
Bendix Aviation Corp.,
  Bendix Products Div. 30
  Red Bank Div. 62
  Scintilla Div. 73
Binkley Mfg. Co. 56
Blocksom & Co. 63
Breeze Corp. 71
Brunswick-Balke-Collender Co., The 12
Bulova Watch Co., Electronics Div. 48
Bulow Electric Co. 59
Cannon Electric Co. 19
Computer Engineering Associates, Inc. 72
Connecticut Development Commission 25
Consolidated Diesel Electric Corp. 64, 65
Delavan Mfg. Co. 45
Designers for Industry, Inc. 35
Douglas Aircraft Co., Inc. 7
Electrical Engineering & Mfg. Corp. 8
Ex-Cell-O Corp. 69
General Electric Co. 60
Goodyear Aircraft Corp. 3
Hamer Valves, Inc. 58
Hughes Aircraft Co. 34
Hydromatics, Inc. 16, 17
International Business Machines, Corp. 24
Kahn & Co. 59
Kearfott Co., Inc. 28
Lebanon Steel Foundry 66
Ling Electronics, Inc. 92
MB Mfg. Co. 40
Martin Co., The, Orlando Div. 47
Master Specialties Co. 86
Millipore Filter Corp. 52
Minneapolis-Honeywell Reg. Co., Boston Div. 91
Nadella 79
National Electric Products Corp. 6
North American Aviation, Inc.,
  Missile Development Div. 67
  Missile Div. 61
  Rocketdyne Div. 55, 75
Packard-Bell Electronics Corp., Technical Products Div. 74
Pennsalt Chemicals Corp. 29
Pesco Products Div., Borg-Warner Corp. 18
Radio Corp. of America 46
Republic Mfg. Co. 58
Servomechanisms, Inc. 2
Simmonds Aerocessories, Inc. 80
Standard Steel Works Div., Baldwin-Lima-Hamilton Corp. 26
Standard Tube Co., The 70
Stromberg-Carlson Co., Div. General Dynamics Corp. 10
System Development Corp. 36
Telecomputing Corp. 23, 83
Thompson Products, Inc. 84
Townsend Co., Cherry Rivet Div. 81
Utica Drop Forge & Tool Corp., Div. of Kelsey Hayes Co. 49
Vickers Inc., Div., Sperry Rand Corp. 42
Vinson Mfg. Co. 76

EMPLOYMENT SECTION

Chance Vought Aircraft, Inc. 88
General Electric Co. 89
Marquardt Aircraft Co. 88

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The Pentagon's Real Manpower Shortage

There has been a great deal of debate, public and private, about the amount of money being spent in all areas of the missile business, for research, for development and for production. So great has this volume of words been that it has tended to obscure a greater problem involved in the nation's technological advances.

This factor is—that the man in the program is at least equally important to the money. For it is the man in the program who makes the decisions —or perhaps fails to make them—as to how the money available will be spent. Money spent for the wrong program may be less dangerous, actually, than money which is not spent for the right one.

This leads almost automatically, then, to the men we get or are able to get in government today, their qualifications, their motives, their authority, their frustrations.

The danger in the Pentagon, where the great majority of missile and space projects survive or perish, is the frightening pyramidal system whereby civilian official has been piled on civilian official, by the hundreds. Many of these officials are honestly motivated and capable. Others are just plain incompetent.

And, the even greater danger is that the vast majority of these officials, even those in the highest ranks, haven't the power to approve projects, but they do have the power to stop them. This inevitably brings about the situation which exists to some degree now. Some of the dedicated men stay on, fighting because they are so dedicated. Others, less so, give in to the frustrations and leave. The result is a tendency toward mediocrity—men who have the talent and training to question a project but not sureness and courage to approve it.

A case in point at the moment is the inability of Defense Secretary McElroy to find a man sufficiently capable to take the vitally important job of assistant for Research and Engineering. The truth is that the terms of reference for this job are so vaguely defined that, as some one has remarked, anyone smart enough to handle the job is too smart to take it.

To do any kind of an adequate job, the man who accepts needs a great deal of authority. He should, in effect, be able to:

1. Approve a project.
2. Allocate the money.
3. Direct one of the services to carry it out.

As matters stand, no one knows for sure (if Mr. McElroy does, he isn't telling) whether the new appointee will have authority over the service assistants for R&D; what his relationships will be with Missile Czar William Holaday, a notable stumbling block in his own right; with ARPA's boss, Roy Johnson; with Comptroller McNeil, who doesn't give up authority on money easily; with NASA or even with his own two bosses, McElroy himself and Deputy Secretary of Defense Donald Quarles, another man with well defined ideas in the research and engineering fields.

The nation's missile and space program is reasonably well muddled now, with some pretty vague areas of operation and authority. The appointment of the right man with the right terms of reference could clear up the situation a great deal. Otherwise we have just added another factor in a space age equation whose components are highly unlikely to add up to a correct answer to as vital a problem as this country has ever faced.

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NEW PRODUCT BRIEFS

ECTOR—Acromag, Inc., Detroit, re-y announced development of a el 510 Cyclemag magnetic fre-cy detector to measure audio fre-cies directly, using only static com-nts. It is recommended for critical le, aircraft and industrial control oments where accuracy, reliability long life are important. The new delivers 0-5—ua of DC output for) CPS input. Accuracy is better 1%, despite large changes in driv-voltage and in driving waveforms. nal power sources are not required he detector uses the signal source s sole source of energy.

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VER—Development of a 24-32 volt 00 ampere DC power supply, com-ly transistorized and militarized, has announced by Perkin Engineering ., El Segundo, Calif. The new r supply designated Perkin Model M-1136A operates from an AC in-of 208 volts ±10%, 3 phase, 57-63 s per second. The unit has a DC nt overload capacity of 125 am-for a duration of 15 minutes. regulation accuracy is ±0.1% for ges from no load to full load. mic regulation is ±.1% for step ges of 10 volts in the AC line be-187-229 volts and dynamic load ation is ±2 volts for step changes no load to full load or full load load. The output impedance is han 0.025 ohms from 0-20KC and is 20 millivolts RMS maximum.

No. 244 on Subscriber Service Card.

GRAMMER—Model FP 2 and l FP 6, Pamona Electronics Co. new sequential programmer is a electro-mechanical precision timing e, with missile application. The eight unit eliminates the need for es, cams, snap-action switches, and ny instances relays, according to anufacturer. Accuracy of 0.2 sec-can be obtained, and total oper-time available is from 15 seconds) seconds, with other time settings le. Switching contacts during the timing run can be as short as 0.5 seconds or as long as the total operating time.

Circle No. 245 on Subscriber Service Card.

THERMAL MACHINE—A thermal fatigue test machine located at International Nickel Company's Bayonne Research Laboratory in Bayonne, N.J., automatically heats alloys to high temperatures, then cools them to produce repeated thermal shocks. The machine helps engineers learn more about the complex effects of repeated stressing induced by thermal cycling. The problem of temperature measurement, as the machine automatically indexes through the heating and cooling cycles, is neatly solved with a Leeds & Northrop Co. radiation pyrometer. A specially mounted Rayotube radiation detecting element on the machine connects to an L&N Speedomax AZAR (adjustable range, adjustable zero) recorder.

Circle No. 246 on Subscriber Service Card.

SERVOS—Servo Dynamics Corp., of Somersworth, N.H., has announced a complete line of miniature precision servo AC motors of 60 and 400 cycles in the frame sizes 8, 10, 11, 15, 18 and 23. The line includes damping generators, inertia damped motors, precision tachometer generators, synchronous motors, and a variety of associated precision gear trains. The motors are guaranteed to operate within ambients up to 200°C and are designed to give the maximum enclosure for protection against environmental conditions. All units are designed to meet BuOrd specifications and are either certified or can be certified to meet the environmental requirements of MIL-E-5272A.

Circle No. 247 on Subscriber Service Card.

DELAY LINES—Three new distributed parameter electrical delay lines, having delay periods ranging from .05 to 1.0 microsecond per six inch length, have been developed by Technitrol Enginnering Co., Philadelphia. The new delay lines types 25E, 25F and 25G are available in a variety of standard case styles.

Circle No. 248 on Subscriber Service Card.

MISSILES AND ROCKETS

OCTOBER 20, 1958

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26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
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101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

- **Missile Literature**

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

- **New Missile Products**

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
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MISSILE LITERATURE

ELECTRONICS—A four-page short form catalog is available from Eldorado Electronics, 2821 Tenth Street, Berkeley, California. The new bulletin briefly describes Eldorado Electronics Accelerator Current Integrator, Universal Photomultiplier Photometer, Milli-Microsecond Time-To-Pulse-Height Converter, Multi-Channel Pulse Height Analyzer, Non-Overloading Linear Amplifier and Milli-Microsecond Time Measuring System. Features, specifications and price are noted.

Circle No. 200 on Subscriber Service Card.

RECTIFIER—General Electric has published a 17-page booklet, entitled "Application Notes for ZJ-39A Silicon Controlled Rectifier" which describes circuit fundamentals for use of the newly developed rectifier. The controlled rectifier is basically a rectifier which is modified to block in the forward direction until a small pulse of current is injected into the gate terminal. After this, it assumes the forward characteristic of a conventional rectifier. The booklet covers general circuit design considerations, firing circuit design and typical applications for the silicon controlled rectifier. "Application Notes for ZJ-39A Silicon Controlled Rectifier" is General Electric publication number ECG-327.

Circle No. 201 on Subscriber Service Card.

FILTERS—The Bausch & Lomb Optical Co. has recently published Progress Report No. 3 entitled "Near-Infrared Transmission Filters." The report summarizes the technical data which has been compiled by the optical company on the selective transmission of energy through multilayer interference filters. The text of the third report provides a detailed description of "Band Pass Filters" and "Long-Wavelength Pass Filters." Each is outlined according to specific terminology and filters characteristics. Statistical tables and charts supplement the text. In addition, the report includes data on auxiliary filters, composite filters and substrates as well as general information on size, maintenance and availability of items.

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COMPONENTS—Wyle Associates Bulletin Number Six describes a new line of environmental test equipment for mass-testing of production components. "Building Block" units are available in combinations. Environments obtainable include high-low temperature, salt spray, altitude, humidity, vibration, shock, temperature shock, sunshine, fungas, rain, sand-and-dust, radiant heat, immersion, accelerated corrosion, and explosion.

Circle No. 203 on Subscriber Service Card.

CABLES—A new four-page booklet describing Triangle Control Cables, the various construction available as well as suggested applications, is offered
Triangle Conduit & Cable Co., I
New Brunswick, N.J. The booklet
the various sizes of control cables
describes the sheaths and insulati
used.

Circle No. 204 on Subscriber Service C

MOTORS—A 10-page catalog desc
ing four basic models and sizes of A
hysteresis synchronous and induct
motors and 129 spur and planetary g
reductions, is available from Glove
dustries, Inc., 1784 Stanley Avenue, D
ton 4, Ohio. The motors operate
A.C. voltages to 200; 400 or 60 c
1, 2 or 3 phase. Geared outputs ra
to 2000 oz. in. Performance, MIL sp
fication and other technical data
given.

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VALVES—A four-page brochure
scribes the basic types of air valves
actuators manufactured by Barber-C
man Co. Temperature control and p
tioning systems, and specialized el
trical test equipment are also includ

Circle No. 206 on Subscriber Service C

FEEDERS—RCA has a full line broch
on automatic parts feeders. These
clude: non-mar feeder-orientors for h
dling fragile and highly finished pa
elevating oriented feed hoppers, st
feeders, and rotary hoppers. Also sh
are automatic high speed hardness t
ers, inspection machines, grinder c
trols and other products of RCA's
Industrial Automation Equipment S
tion.

Circle No. 207 on Subscriber Service C

OSCILLOSCOPES—A bulletin availa
from the Industrial Products Divis
International Telephone and Telegr
Corporation, 250 Garibaldi Aver
Lodi, New Jersey, describes the
40BG and AC-40BG 17" bar-gr
oscilloscopes. Any 40 related or u
lated variables which can be conver
into electrical impulse may be si
taneously compared or measured
their change or drift studied by me
of the instrument which provides
large and accurate display. Model
40BG is a polarity-indicating low-l
system, Model AC-40BG is a wide b
system. The illustrated bulletin inclu
recommended applications, a gen
description of the instruments plus
special features, and technical spe
cations.

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CONVERTERS—A new six-page fol
describing the complete line of L
Liquid Oxygen and Nitrogen convert
is now available from Linde Co., D
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counts for very low weights.

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151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175

• • **Missile Literature**

200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224

• • **New Missile Products**

225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249
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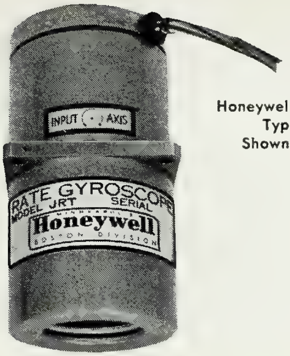
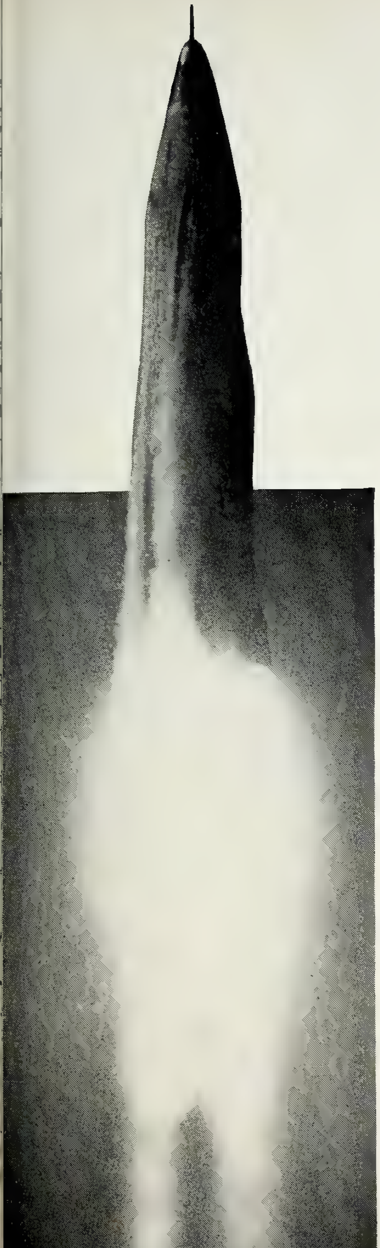


Honeywell Rate Gyro
Type JRT
Shown ½ size



First test firing of the ATLAS ICBM at Cape Canaveral, Florida, June 11, 1957.

Flight Control for the ultimate weapon

Three Honeywell Rate Gyros, Type JRT, provide missiles with precise three-axis directional stability and are currently being supplied to the ATLAS missile program.

The Type JRT is a highly accurate precision instrument for measurement of absolute rates of rotation in inertial space. Viscous damping is electro-mechanically controlled to maintain a constant damping ratio over the entire operating temperature range of −65°F. to +175°F.

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prescription for a successful orbit

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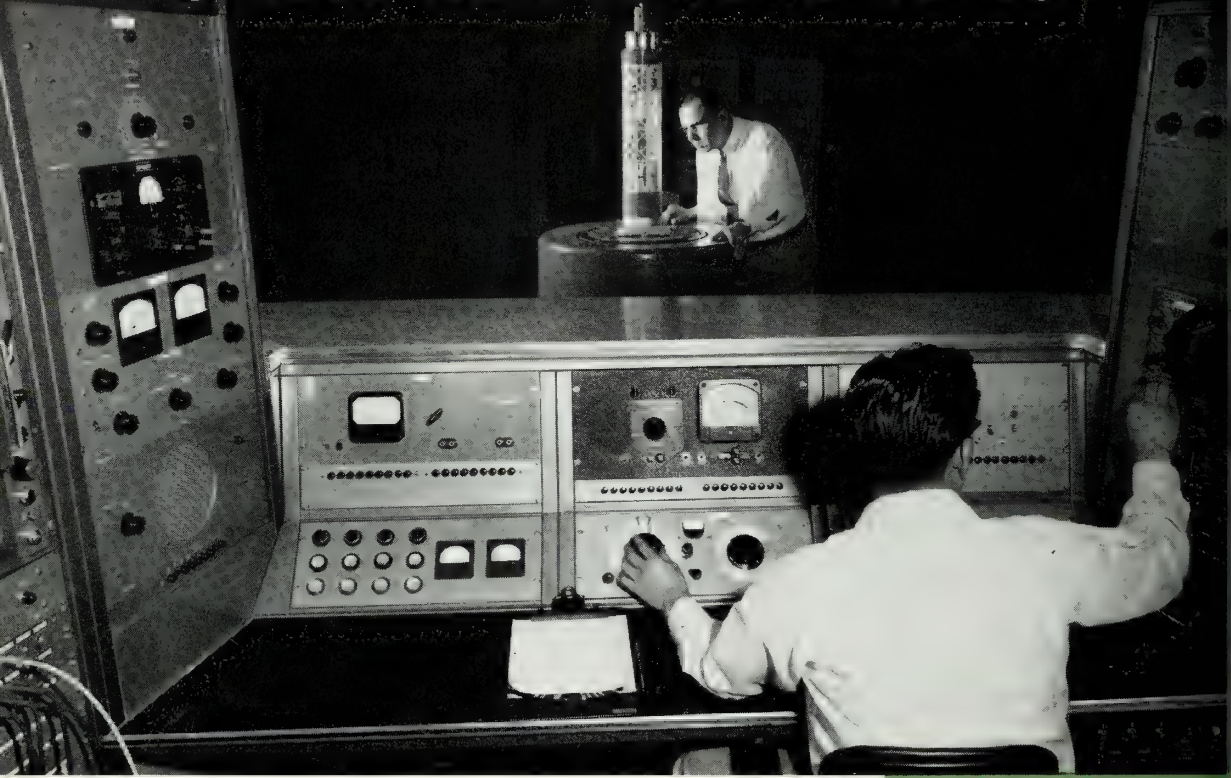


Ling vibration testing proves reliability of Explorer satellites before launching

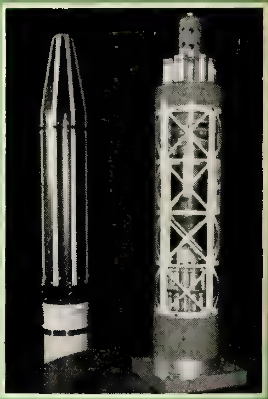
THE SUCCESS STORY of the Explorer Satellites actually began long before the countdown. Every piece and component was vibration "flown" again and again through endless testing and checkout procedures.

In fact, the *fully assembled* Explorer Satellites now in orbit were given a thorough vibration testing at Caltech's Jet Propulsion Laboratory in Pasadena, California.

The actual conditions of space flight were computed in a synthesized program, and, using Ling Electronic power generators and advanced techniques, space flight conditions were duplicated in the laboratory!

The ability to develop complex test equipment for new and challenging areas such as this is one of the reasons Ling is recognized as a leader in high power electronics.

Because of the conditions encountered in the flight to space, a random wave program was the only vibration test considered realistic enough for the Explorers. Tests at JPL included random noise band limited to 20-1500 cps with an amplitude as great as 25 G rms perpendicular to the thrust axis. Shown on the shaker table is an Explorer instrumentation package.



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OCTOBER 27, 1958

MINUTEMAN—Second Generation ICBM

missiles and rockets

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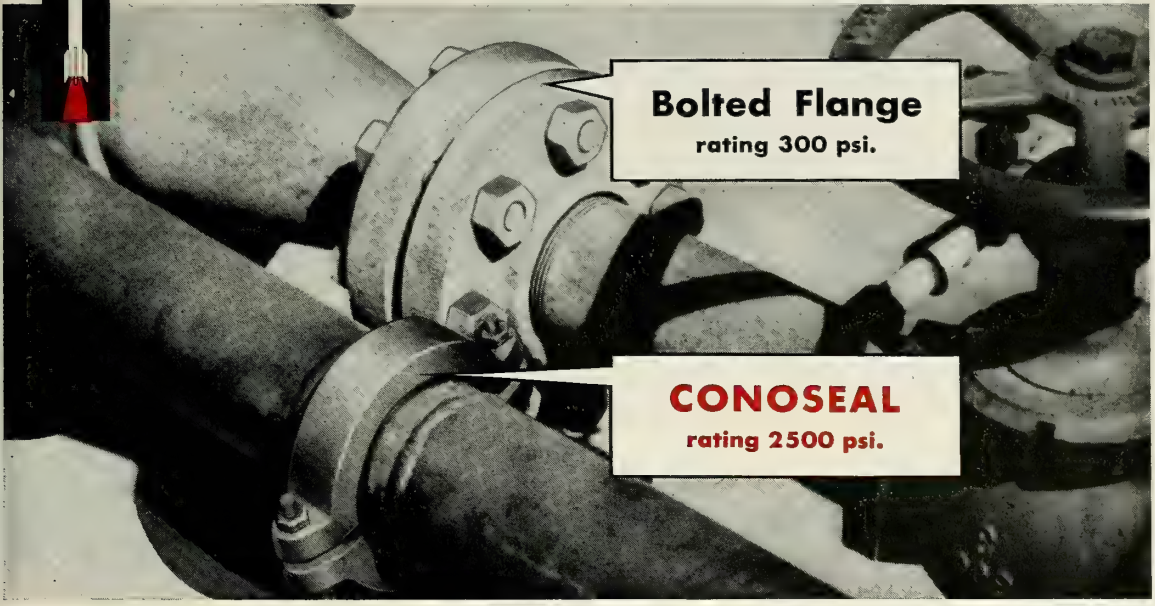

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Where extremes of pressure and temperature are standard operating conditions for fluid lines, specify the all-metal Marman Heavy-Duty CONOSEAL Joint. It is designed to provide absolute dependability in connecting and sealing piping, even when subject to severe shock and distortion.

Marman Heavy-Duty CONOSEAL Joints provide maximum insurance against leakage or failure where dissimilar materials must be joined, such as stainless steel to aluminum or Zercoloy. Made entirely of metals not subject to deterioration, CONOSEAL Joints have long shelf life, require no maintenance.

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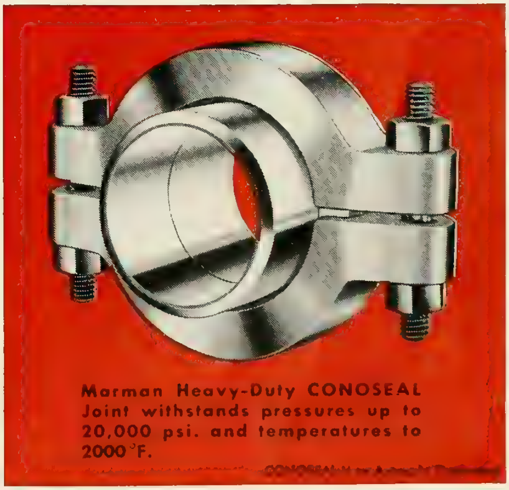

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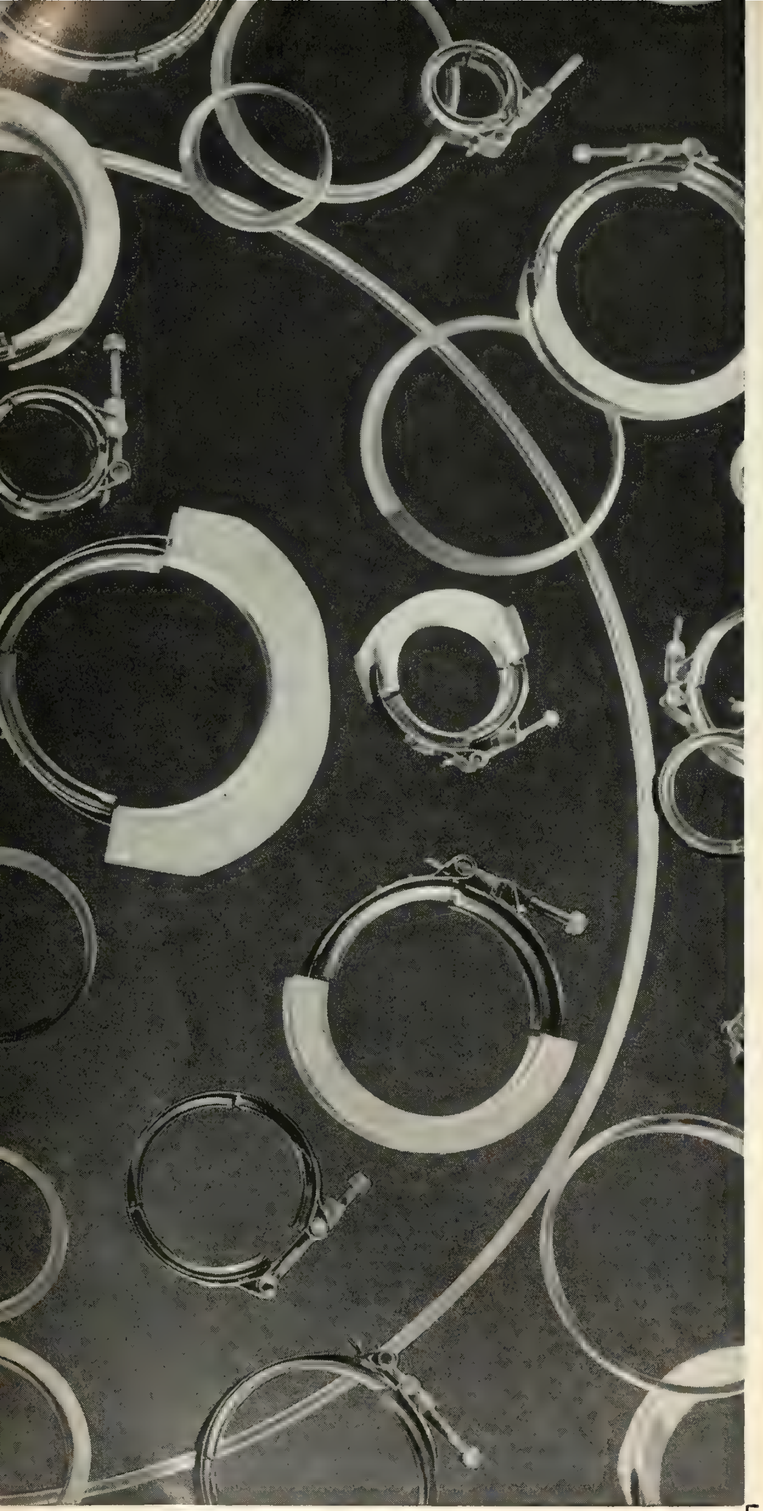

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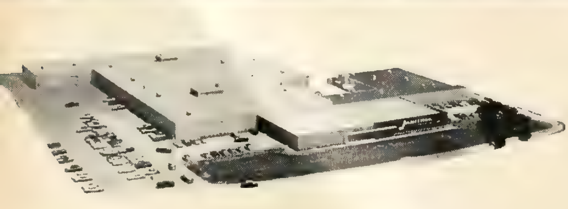

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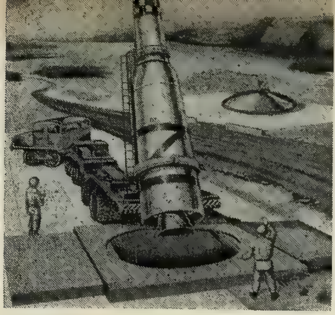

COVER: *An ICBM* Minuteman *is lowered into its "sunken silo" hardened base. The* Minuteman *system—which will be deployed in 1961-62 along highways, roads, and railroad tracks—should have easy maintenance and be a minimum target risk. (See p. 20)*

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missiles and rockets Vol. 4, No. 17, Oct. 27, 1958

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in this issue

OCT. 27 HEADLINES

Missile Industry Mergers
Survey by m/r shows the real reason behind them is to gain technically competent personnel 12

ABMA Transfer to NASA: Good or Bad
Space Council meeting on October 28 could see important decision made on civilian-military liaison committee 28

Association of U.S. Army Meets
It's not said officially, but behind the scenes there's talk of Army losing missile capability 29

ASTRONAUTICS ENGINEERING

Data Out on Large Russian Rockets
Some details known about 600,000 pound thrust engine 16

Motion Simulator Tests *Polaris*
"Shaker" device in operation at Cape Canaveral 30

MISSILE ELECTRONICS

Precise Measurements Necessary for Space
Time: temperature, meter bar being researched heavily 24

Electronics Fifth Biggest Business
AOMC's General Medaris cites future 25

Missile Monitor Readied
Hughes system unveiled for air defense 32

DEPARTMENTS

In My Opinion 7
Washington Countdown .. 9
Industry Countdown 11
Propulsion Engineering ... 18
Missile Business 27
Missile People 34
Contract Awards 35

Missile Metal Machining

The picture below shows a guided missile component of A-286 alloy being machined on a 48″ Monarch Air Gage Tracer Lathe at Diversey Engineering. Nowhere else can you get such extensive facilities for contour machining of Titanium, Inconel, A-286, Haynes Stellite and Zirconium.

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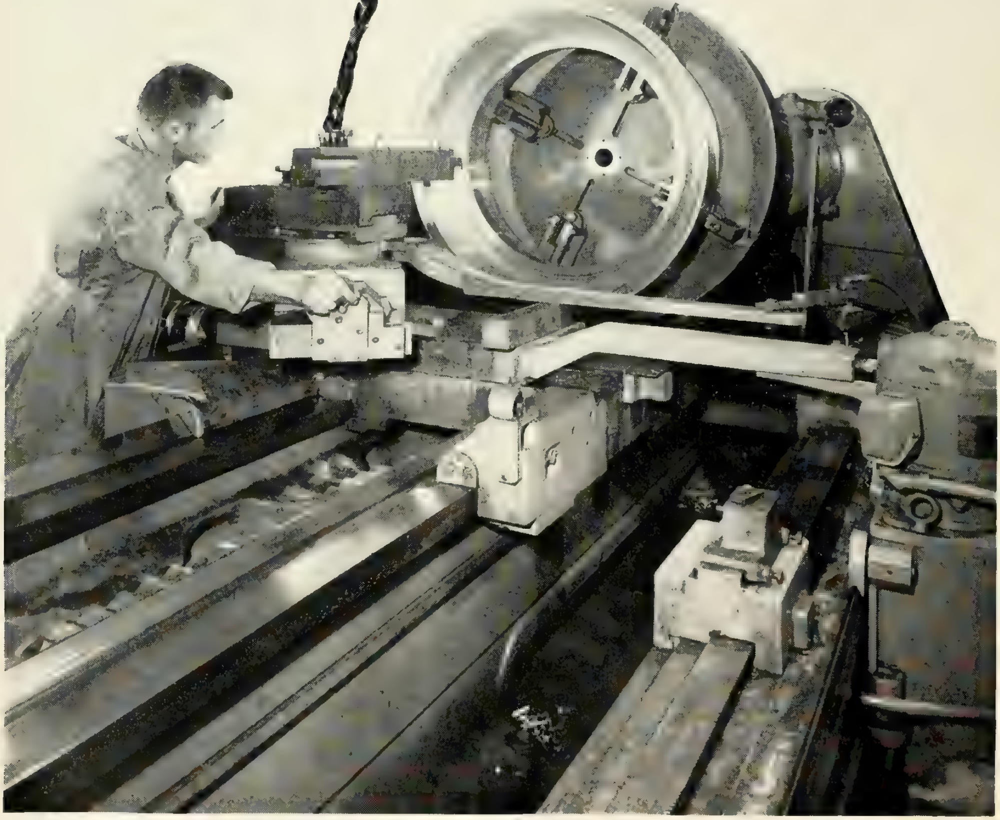

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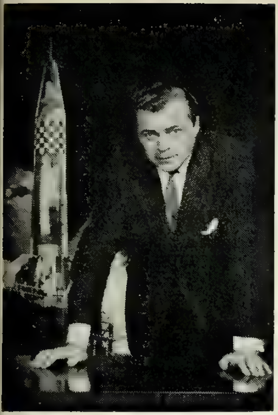

In My Opinion . . .

. . . the nation's missile and space flight progress is in grave danger of being slowed down again. Once more the spirit and morale at Redstone is at a rock bottom low. Once more Wernher von Braun has been forced to tell his scientists to keep up the good work, to ignore the political footballing, to avoid any let-down—in spite of the fact that the axe is again being lowered over their heads.

It will take weeks, and more probably months, for the Administration to finalize the decision to transfer the ABMA rocket science team to NASA, although the decision probably will be made before the end of the year. This is the statutory time limit and the only way the President can take such action without approval of Congress. But in the meantime—while the future of the nation's greatest rocket development team is being determined by election-minded Washington politicians—this same team is expected to advance successfully a major share of our most important missile and astronautics work.

In addition to the accelerated *Explorer* program, which represents this country's only worthwhile satellite program so far, the ABMA team is preparing two lunar shoots which the entire world is awaiting anxiously—a series of *Juno* IV communications satellites, the *Pershing* ballistic missile, ballistic freight and manned rocket carriers, an anti-ballistic missile, and other highly secret and crucial projects—projects that play an important role in this nation's cold-war struggle with Russia.

For many years, the Army missilemen have been given one blow after another—in fact, we cannot think of any other defense development group that has had better reason to become discouraged, disillusioned and distressed in their efforts. Yet this team, under the brilliant leadership of von Braun, has continued to pursue the goal of putting this nation ahead. The progress of this team is unparalleled—ranging from development of the first IRBM to this country's first satellite. And there have been other important break-throughs—less publicized—such as the ballistic missile nose cone development for less than $4 million (other missile builders spent $400 million doing the same thing later).

At the present time—since we do not know the details of the proposal to transfer the ABMA team to NASA—we cannot voice an opinion as to whether the proposal is good or bad. However, it can be stated that every effort must be made to back up the ABMA morale and spirit. This team must know that every man and woman in the Free World is thankful for the team's efforts. The ABMA scientists must be told that the nation will demand that only the very best decision is good enough for them. They should also be reminded that the current Administration has only a short time to go—and that in the end, free men and women will have the final voice in electing better people if the right decisions are not made.

Finally, let us appeal to Army Secretary Brucker to show his old vigor in this battle! The ABMA team needs your support, Mr. Brucker. Why not show them that you are determined not to let Army technology go without a fight?
fight.

Erik Bergaust

Think small

Mechanical brains for missiles must be as tough and tiny as possible . . . a design problem that calls for experts skilled in both electronic computers and miniaturization.

ARMA's computer group has shrunk a digital computer module until it's the size shown above . . . a feat comparable to squeezing the contents of a steamer trunk into a cigarette package.

Right now, in fact, through new techniques of solid state circuitry, systematic design and compatibility testing, ARMA is producing a family of airborne digital computers that are operational under the most severe conditions of vibration, temperature, noise, acceleration and deceleration, and nuclear radiation.

For information on our fully transistorized, airborne digital computers, contact ARMA, Garden City, N. Y. A division of American Bosch Arma Corporation.

5836

AMERICAN BOSCH ARMA CORPORATION

washington countdown

Third AF moon shot . . .
will be ready on schedule, according to General Bernard Schriever's Ballistic Missile Division. BMD doesn't share any Pentagon doubts that alterations to beef up guidance and propulsion systems can be completed by Nov. 7.

Watch for a fight . . .
on hard bases for *Titan*. One faction feels that the job can best be done by large engineering firms with construction work integrated into the various local economies. But the *Titan* feud will be largely academic. The real plum will be the many hard bases required for *Minuteman*.

Turning the tables . . .
the Navy has announced testing of a new research rocket, *Arcas*, developed by Atlantic Research. Designed for a low acceleration rate, it is used for atmospheric research. The low speed eliminates need and expense of ruggedizing instrumentation.

Despite two failures . . .
Navy spokesmen are talking up putting *Polaris* missiles on all types of surface vessels plus submarines. Arming with *Polaris* conceivably could put many ships now in mothballs back into service.

Secretary of the Navy . . .
Thomas Gates probably will make known his intentions—whether to stay or resign—within the next two weeks. Reason: election. If he leaves, the job could go to one of the GOP entries who placed well but did not win, or to a governor completing a term whom it would be desirable to keep in the public eye until 1960.

But the job's up for grabs . . .
with Undersecretary Franke the unknown factor if the post is vacated. Franke wants the job. Or he may swap for Asst. Defense Secretary W. J. McNeil's comptrollership, with McNeil taking top Navy spot. Best bet for an outsider is James Smith of ICA. Rep. Wigglesworth, once a possibility, may become ambassador to Canada.

International space plan . . .
advocated by House Astronautics and Space subcommittee will bring no objection from military—but Pentagon says it wants to be sure nothing but pure science is involved. All are for freedom of science, but don't want the Russians to cut themselves into a one-way clearing house.

Transfer of projects . . .
to NASA is looked upon much more favorably than transfer of personnel. While the proposal that the Huntsville team should go to NASA stirred controversy, many military figures like the transfer of purely scientific programs such as *Vanguard* which were nearer pure science, but came out of military money.

Ironical missile paradox . . .
is that many conscientious U.S. R&D scientists are quietly hoping Russia will at least equal many of our space developments in near future. Otherwise—complacency, smaller appropriations, and lack of urgency may result on our part.

Boeing had to win . . .
the *Minuteman* competition, some wag remarked. Otherwise the company backlog might have dropped considerably below the two billion mark.

Another U.S. satellite . . .
was being readied as m/r went to press. Reports were that the Army would use a *Jupiter* C to launch NASA's 12-foot inflatable sphere.

X-15 roll out . . .
coming closely on heels of the 80,000 mile lunar probe, sent spirits soaring in Washington. Optimistic predictions are that first glide tests of the X-15 will be in December with a first rocket-powered flight late in the month. Full scale tests are still many months away.

RCA added . . .
another department to its large Defense Electronics Products Division with the dedication of its Missile Electronics and Control Department in Burlington, Mass., active in the *Nike-Zeus* program.

AIR FORCE's TITAN

The liquid-propellant rocket engines for the Air Force TITAN ICBM were designed and developed at our Liquid Rocket Plant near Sacramento—America's largest industrial rocket facility. Production engines are now being delivered.

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industry countdown

AMC has been accused . . .

by the International Association of Machinists, AFL-CIO, with "coercion at the collective bargaining table" in the aircraft and missile industries. IAM states that DOD policies and actions amounted to illegal wage control—the fixing of ceilings on wage rates without authority from Congress or the White House. AMC told m/r that its procurement follows instructions issued by DOD to all services and it does not become involved in negotiations between management and unions. However, the Air Force will not necessarily adjust payments to meet agreements made by union and contractor after contracts are made.

New contracts . . .

for "Jack Blade and his Green Mountain Boys of Huntsville," (American Machine & Foundry). AMF has landed a contract for $1,685,000 with Republic for flight calculators and $1,768,000 with GE for radar antennae.

More mergers . . .

with Jetronic Industries of Philadelphia acquiring two Florida concerns in a transaction designed to insure a larger share of the missile market. Jetronic, producers of electronics test equipment, with plans for a major expansion in missile instruments, purchased Centronix, Inc., and the Atlanta Land & Manufacturing Co., both electronics component manufacturers.

Large grain solid lag . . .

is indicated in the recent disheartening launch failure of the second full-size *Polaris.* Instability in burning of the first stage was observed in the latest firing—a major problem area of past years. Last two firings have been operational configurations produced by Aerojet-General. The series of earlier test vehicles were lash-ups of the reliable *Sergeant* tactical missile produced by Thiokol.

Industry investment . . .

of tremendous R&D money for civilian goods could also be channeled into defense R&D if there were a climate of adequate profits. GE points out the constant glare of publicity on all non-classified projects in defense R&D and the inevitable technical troubles tend to lead to public discouragement and a loss of confidence in a company and its products. The pronounced effect on U.S. economy is illustrated by the fact that 1958 R&D expenditures will be about $10 billion, representing only 2.3% of the gross national product predicted for the year.

Promising market awaits . . .

the metals industry if and when a suitable means of processing beryllium from its ore is found. Forming and machining is a minor problem report the companies now producing such beryllium items as jetavators for solid propellant rocket control, and nose cones for *Atlas* and *Thor.* Its high heat resistivity would make it ideal for leading edges and high-drag surfaces on future space vehicles as the *Dyna-Soar* and manned satellite re-entry vehicles.

X-15 subsystem . . .

manufacturers announced at the roll-out of the first vehicle include: General Electric supplying two hydrogen peroxide APUs for providing electrical and hydraulic power; Sperry Gyroscope, inertial flight data system for providing data enabling the pilot to control the research craft during the critical period experienced at launch through the high acceleration period and at re-entry into the earth's atmosphere; Lear, Inc., a three-axis indicator showing attitude of the X-15 in relation to the earth during exit and re-entry; Bell Aircraft, control rockets for control above the atmosphere; and the Garrett Corp., responsible for a liquid nitrogen air-conditioning and pressurization system.

Target missiles . . .

demand heavy share of defense budget as indicated by the size of contracts awarded to Lockheed for its *Kingfisher* missile evaluation system. Latest award of $2,786,953 by Army Ordnance brings the total for this system to more than $10-million since the original contract was executed last June. *Kingfisher* is loaded with highly complex electronics instrumentation, including a firing error indicator for ground control intelligence of the proximity and approach angle of interceptor missile and radar device for simulation of attacking aircraft.

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missiles and rockets
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special m/r survey . . .

Missile Mergers: Brains Are Target

by E. E. Halmos, Jr.

WASHINGTON—The increasing number of mergers within industries serving the missile field during the past year is sparked principally by the need for technical know-how.

And while the mergers promise better stability for the field, they emphasize the desperate shortage of technically trained people and technical knowledge in a field that is of vital importance to U.S. safety and progress.

That's the key to an m/r survey of business activity in the diverse industries that serve the missile field.

Other factors, turned up in m/r's partial survey indicate that:

1. The mergers, combinations and acquisitions between companies in the missile industry have resulted in practically no loss of top scientists, although some management skills have undoubtedly been pushed out.
2. Physical assets such as machinery or overall plant area in most cases apparently are minor considerations when one organization considers acquiring another.
3. A majority of the mergers are in the electronics and telemetry fields, reflecting again the need for small capital investments—but with large investments for technological "capability."

Transactions Increase—

The m/r study was prompted by the voluminous reports over the past year—and increasing during the past three months—of new alignments among manufacturers. The accompanying table, (p. 13) for example, lists some 30 such changes, and represents only a skimming of the actual transactions that have been concluded, or are in process.

In addition to the actual mergers, outright purchases (or stock exchanges), there have been dozens of other activities that indicate the strength of the trend: The establishment of special divisions within companies to handle special phases of missile work; joint ventures between companies for missile work, such as that announced recently by Vitro Corp. of America and the Koppers Co.; licensing agreements with foreign manufacturers, and the like.

To business observers, there's nothing new in the trend—except possibly the speed with which it has become apparent. Nearly every other major industry in U.S. history—and the missile industry today is a formidable one—has started in the same way, with thousands of small manufacturers, "tinkerers and individuals," getting in at the start, developing some facet of the technology, then by combination or absorption (or poor business practice) being welded into a stronger, larger organization.

But it took the automobile industry, for example, 40 years or more to achieve its present monolithic state. The aircraft industry has been strengthening itself for more than 30 years.

And in missiles, the trend is coming within two years, as nearly as anyone can set boundaries on the actual start of the business.

Canada Fears Loss of Specialists to U.S.

Canadian manufacturers and government leaders are frankly afraid that U.S. firms will make a serious dent in Canada's reservoir of electronics specialists.

Delegates to the Institute of Radio Engineers convention at Toronto officially warned the government that when the Avro CF-105 jet program is terminated next year, some 475 specialists on electronics will become prime targets for U.S. firms—some of which have already sent interviewers into Canada.

Merger Considerations—

The reason for the speed, of course, lies in the reason for the mergers.

The great rash of consolidations that hit U.S. industry shortly after World War II was dictated by three major considerations: An attempt to diversify the product line in order to keep alive in the expected let-down from wartime economy; the need to acquire physical plant and distribution facilities at a time when heavy industry was still aligned for war production; and—most attractive of all to many a company official—possible tax loss to be claimed through assuming the obligations of a faltering organization.

But in missiles, the spark continues to be the need for quick acquisition of technical know-how. The physical assets possessed by many of the small companies which have disappeared into the maw of larger ones are often hardly worth considering—a small shop, a few machines. In many cases, their financial position has also been sound enough.

Official Opinion—

A concensus of the top officials contacted by m/r could be put in such a statement as this:

"This business is only a couple of years old—yet it is already expanding into so many fields of highly specialized knowledge and theory that we haven't had time to develop the people or the technical libraries that should be available if we are to meet the fantastic requirements made of us.

"But such knowledge does exist in many places—in out of the way companies, and corners, in the minds of men who have been working away at some special phase for some years.

"We could, of course, attract some of these men and some of this information with high salaries, extensive search, body-snatching. That costs a lot of money, takes a lot of time. And we don't have the time.

"So the simplest thing to do is to buy the whole thing, wherever we can get it, at the best price we can negotiate."

An example is The Martin Company, which has been openly looking around for an electronics company for some time. Martin has manufacturing capability, considerable know-how built up over years in the aircraft field and experience over many years in missile work. But it has not had time to develop enough electronics specialists in its own shop.

Why Electronics?—

The heavy emphasis on electronics is of course further evidence of the direction in which missile work must go, and where its weakest link lies.

There have been some consolidations on the side of manufacturing operations—but in general, manufacturing techniques haven't changed so much that old-line machining techniques and knowledge can't be applied. The materials are often newer, harder, or have other characteristics that differentiate them from more conventional industrial components. But the techniques for handling them are general refinements of long-known methods.

But electronics is a new business, and it calls for methods, materials, production techniques and knowledge that was unheard of two years ago. Often, it calls for methods that are apparently not economically possible for a large concern.

And of course, the electronics end of missiles is as close to mass production as the field can offer. While only 50 or 60 of any particular model of the big ballistic missiles may ever be built—each of these monsters may include more than 300,000 parts, many of which fall into the electronics area.

As things stand now, the major prime contractors are forced to subcontract much of this work. It has been estimated that more than 70% of all missile money goes out from the prime contractors to subcontractors. And the electronics and telemetry items are the "high markup" items in the business. It makes sense, business-wise, for the prime contractors to want to keep some of this business under their own roofs.

Exceptions—

There are exceptions, of course, to this general picture. Probably most typical was the acquisition early this summer of the engineering firm of Haller, Raymond & Brown by the Singer Sewing Machine Co., of Hartford, Conn.

The situation here was more typical of business mergers: Singer had a plant at Hartford—an area where skilled labor was then in oversupply—which had been set up specifically to turn out custom-made machines for special purposes, as opposed to its other plants which produce consumer-market machines on an assembly-line basis.

Singer management decided that missiles—or at least missile components—could be manufactured in this plant, to take advantage of existing facilities and skills. A major consideration, also, was diversification of the company's long-established product line.

Obvious answer—buy the capabilities the company didn't possess.

Another answer to the need for technical know-how has been the joint-venture operation. Well known in some industries—such as the construction field, where as many as eight contractors have joined forces to bid in and build a major job—it is relatively new to other industries.

But the demands for technology and special knowledge—and the heavy emphasis on research and development—have almost forced combinations of companies, in order to provide the needed pool of information and capability.

Recent Missile Mergers

Some idea of the speed and size of the company mergers that have occurred in the missile field can be obtained from the following list. This compilation is limited to larger deals as reported in the columns of MISSILES AND ROCKETS over the past three months. It includes only actual mergers or acquisitions, not joint ventures or establishment of special departments or divisions.

In chronological order, here are the transactions:

Litton Industries, Beverly Hills, bought Airton, Inc., Linden, N.J. (July 7).

Singer Sewing Machine Co., Hartford, bought Haller, Raymond & Brown, State College, Pa. (July 7).

Tennessee Gas Transmission Co. and Food Machinery Co. acquired Grand Central Rocket Co. (July 14).

U.S. Chemical & Milling Co. bought in four other companies: Missile Air, Hydro Metal Spinning Co., Foto-Etch Circuits and Paul Omhundro Co. (July 14).

Diversey Engineering Co., Chicago, purchased Warrior Tool & Engineering Co. (July 14).

Underwood Corp. bought Canoga Corp., Van Nuys, Calif. (July 21).

Houdaille Industries Inc., bought in Provincial Engineering Co., Niagara Falls, Que. (July 28).

National Tool Co., of Cleveland, purchased AutoVac Co. of Bridgeport, Conn. (July 28).

Mandrel Industries, Houston, purchased Hall-Scott Electronics of Burbank, Calif. (Aug. 4).

Advanced Industries, of Cambridge, Mass., purchased The Electrolizing Corp. and two smaller firms (Aug. 4).

Pyle-National Co., Chicago, bought in Steber Mfg. Co., Broadview, Ill. (Aug. 11).

Accoustica Asscociates, Inc., bought in General Ultrasonics Co., of New York City. (Aug. 11).

Ling Electronics, Culver City, Calif., absorbed Calidyne Co. of Winchester, Mass. (Aug. 18).

Olin-Mathieson Corp., joined Aluminum Ltd. and two French firms for ore exploitation and chemical work. (Aug. 18).

Beaver Precision Products, Inc., Detroit, licensed Armstrong-Siddley Motors of England to produce electronic products. (Aug. 18).

Acme Precision Products Inc., Dayton, bought in Cal-Tronics, Inc. of Los Angeles. (Sept. 8).

Air Logistics Corp., Pasadena, purchased Polaris Engineering Co. of Inglewood. (Sept. 8).

Chromalloy Corp. of New York, bought Propellex Chemical Corp. of Edwardsville, Ill. (Sept. 15).

Marquardt Aircraft Co. purchased Associated Missile Products Co. (Sept. 22).

General Transistor Corp. of Pasadena, merged with Barnes Engineering Co., Stamford, Conn. (Sept. 22).

Electronics Assistance Corp. of Red Bank, N.J., bought the electronics division of Mack Truck. (Sept. 22).

Litton Industries bought the Westrex Corp. (Oct. 6).

Jetronics Industries of Philadelphia, acquired Centronix, Inc. of Cocoa, Fla., and the Atlanta Land & Manufacturing Co. (Oct. 13).

Thompson Products and Ramo-Wooldridge merger approved by stockholders. (Oct. 13).

USC Operates New Type Hypersonic Tunnel

The University of Southern Califfornia has begun operation of a wind tunnel designed to test missile models under simulated conditions of Mach 20 at 60 miles altitude.

The tunnel, said to be the only one of its kind in the world, has the appearance of a large steam boiler and does not operate in the method of conventional wind tunnels.

Instead of using pumps and fans to blow air over models, the tunnel creates a vacuum at one end by refrigeration. This sucks nitrogen gas from the other end of the chamber and over the missile model. Pure nitrogen is used because it eliminates the necessity of removing moisture from the gas.

Designed by Dr. Raymond L. Chuan, director of USC's Engineering Center, the tunnel was built on a research contract from Air Force Office of Scientific Research and the Office of Naval Research.

A helium refrigeration system designed and installed by Arthur D. Little Inc. employes a method of cryopumping to achieve temperatures ranging from –450°F to +750°F inside the tunnel.

The vacuum pulls the test gas in a fraction of a second, through a tiny aperture, then into an 18-inch-wide tapered throat where it expands and accelerates to speeds around Mach 8. When this tapered throat is opened to a diameter of 40 inches, the tunnel will test at Mach 20.

Due to gas cooling during expansion, electric heating is applied to the nitrogen when it first enters the tunnel and again just before it flows over the subject model. Proper research findings from the tunnel depend on the model being the same approximate temperatures as an actual missile would be.

The second heating, applied just before the gas passes over the model, is done by a new method invented by Dr. Chuan. A small transmitter in the tunnel beams radio waves at the gas, resulting in heat similar to that of radar cooking.

The only moving parts in the tunnel are in the refrigerator, which operates on a 50-horsepower motor. A comparable unit, based on a gaseous diffusion pump, would require about a half million horsepower. Contrasted to the operating time of a fraction of a second for most wind tunnels, the USC unit can function for ten hours.

Ion Engines May Adjust Chemical Vehicle Errors

Ion propulsion may be the answer to trajectory and orbital error in missile and satellite flight, according to Dr. Ernst Stuhlinger, director of the Army Ballistic Missile Agency's Research Projects Office.

Stuhlinger, who has gained recognition for his feasibility and design studies of electrical propulsion systems for space ships said it is possible that smaller scale systems may in the future make the delicate corrections necessary to keep chemically propelled missiles and satellites on course.

Electro-Optics, Inc. of Pasadena, Calif., is under contract to ABMA to conduct research in the fundamentals of ion propulsion, Stuhlinger said. Other contracts are in the works.

The Air Force Office of Scientific Research has let 34 contracts involving ion and plasma studies to the following companies and institutions: North American Aviation, Giannini Plasmadyne Corp., Avco Research Labs, Litton Industries, Ramo-Wooldridge, General Electric, Vitro Lab, Aerochemical Research, Aerojet General, Reaction Motors, Sperry Gyro, Sylvania Electric Products, University of Michigan, Temple University, Johns Hopkins University, Cornell, Princeton, New York University, MIT, University of Maryland, Stevens Institute of Technology University of Illinois, University of Minnesota, University of Oklahoma, University of Southern California, Stanford University, and Polytechnic Institute of Brooklyn.

Advisory Group to Aid NASA Program Plans

An advisory group to assist the Office of Program Planning and Evaluation will soon be set up for the National Aeronautics and Space Administration, according to Administrator T. Keith Glennan.

The space administrator said the advisory group would represent "the best men we can find from industry, educational and research organizations." The OPPE will work closely with Defense Department in the planning of immediate and long-range space programs.

Dr. Glennan made the announcement concurrently with the disclosure that Homer Joseph Stewart, professor of aeronautics of the California Institute of Technology, will head the newly organized planning office.

The newly appointed planning director, who was chief of the liquid propulsion systems division of Caltech's Jet Propulsion Laboratory, has been well-known in American rocketry circles for many years. He played a major role in the pioneering of such rocket projects as the *Wac Corporal*, *Corporal*, *Bumper*, *Sergeant* and *Jupiter C* and later, in the development and launching of the *Explorer* satellites.

Stewart joins NASA November 1.

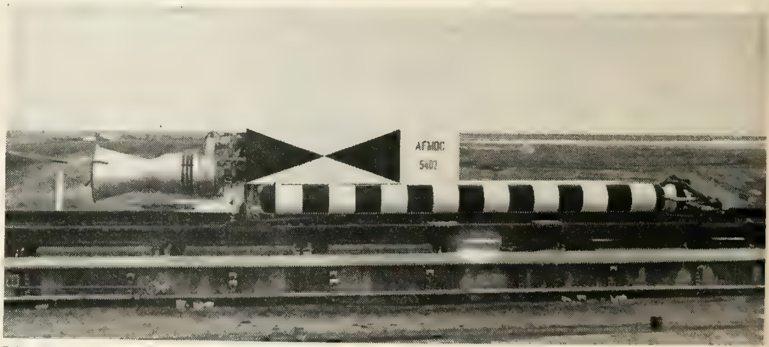
AFOSR's General Gregory Retires After 30 Years

Brig. Gen. H. F. Gregory, commander of the ARDC Air Force Office of Scientific Research will retire October 31 after two-and-a-half years in that post and 30 years of military service. He will be replaced by Col. Benjamin G. Holzman, present assistant deputy commander for research at ARDC Headquarters.

General Gregory, whose first assignment in the research and development area was with the Air Materiel Command at Wright Field, Ohio, in 1938, is considering several offers from private industry.

Col. Holzman, author of 32 scientific papers on geophysics, meteorology and atomic energy, served as staff officer for the 1946 and 1948 atomic tests in the Pacific.

Holloman Liquid Rocket Sled

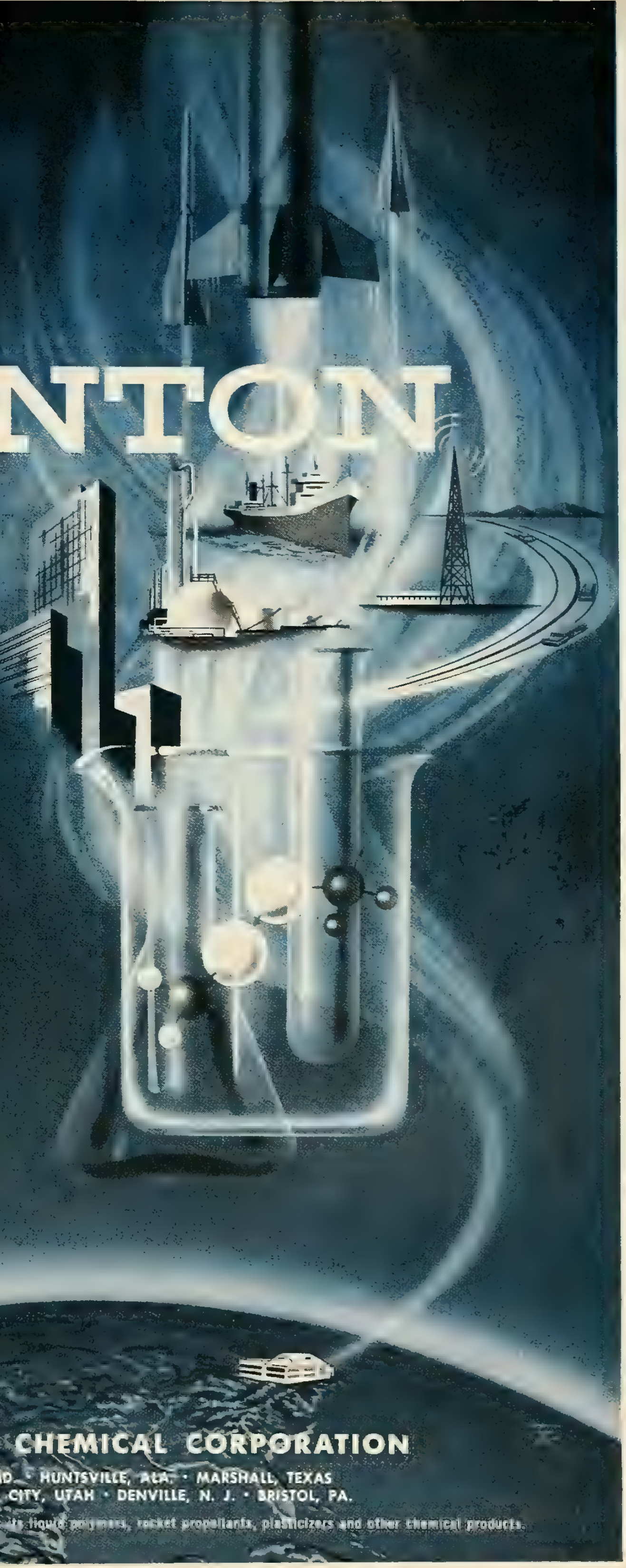


FIRST LIQUID oxygen propelled sled to run on captive missile test tracks is this 50,000 pound thrust development of Rocketdyne. The sled weighs 3,000 pounds; can carry payloads up to 1,000 pounds; and travels the track at 1,100 feet per second.

THIOKOL AT

TRENTON

NEW JERSEY



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Details Emerge on Soviet's Large Rocket Program

Technical Literature Coming from Behind Iron Curtain Giving Valuable Information on Developments Since End of World War II

by **Donald J. Ritchie***

In the past few years there has been a rush of conjecture in this country on the efforts of the Soviets in the fields of rockets and guided missiles. Their success in placing satellites in orbit should leave no doubt as to the success of their efforts.

In the past year many Russian technical publications have found their way from behind the Iron Curtain into the United States. From the material contained in these books, journals, and pamphlets it is possible to construct a rough picture of the development of the rocket engine in the Soviet Union. The early years—through 1940—are fairly clear. However, the postwar years remain a relative blank.

Soviet Rocket Engine Development

Soviet Designation	Designer	Date	Thrust (Lb.)
OR-1	Tsanders	1930-31	11
OR-2	Tsanders	1932	110
ORM-1	Glushko	1931	
ORM-5	Glushko	1932	
ORM-12	Glushko	1932	
ORM-50	Glushko	1933	
ORM-52	Glushko	1933	662
ORM-65	Glushko	1936	342-386
RD-1	Dushkin	1943	651
RD-1X3[1]	Lavochkin	1946	
RD-2	Dushkin	1945	1320
RD-3	Dushkin		1980
R-14	(Team)	About 1950	220,000

[1] Shown at Tushino, August 18, 1946

• 600,000-lb.-thrust engine — But more details are emerging, particularly on a three-stage liquid fuel engine which probably is in the 600,000 pound-sea-level thrust class. A Soviet technical book, for example, illustrates that dual fuel pumps are used in the first stage powerplant, with one on each side of the oxidizer pump. The fuel pumps empty directly to the nozzle where passages bring the cooling fuel back to the combustion chambers which appear to reach almost to the nozzle.

A "guesstimate" as to the nozzle diameter would be about 25 inches. Assuming a combustion chamber pressure of about 800 pounds per square inch, it appears this unit is definitely in the 600,000-pound-thrust class.

The upper stage engines, with their combustion chambers and nozzles, are completely buried in the fuel tank. This is an excellent method to shorten each stage. All stages use jet vanes for steering following the V-2 principle.

The atomic rocket engine also is receiving much attention in the Soviet literature. Considerable effort is expended in the Soviet Union to reduce the physics, technology, and problems to be understood by the Soviet lay reader. As a result, many fine expository books have been published in the area of atomic energy and aviation.

• Rocket background—The first gunpowder rocket factory in Russia was opened at the close of the 17th century for the purpose of producing sky-rockets and other pyrotechnic displays for holidays and celebrations. These factories and workshops constituted the technical basis for the development of rocketry in Russia. Subsequently, for 150 years Russian troops used the signal rocket which underwent almost no change since its appearance in 1717.

The Russian military engineers Alexander Zasyadko (1779-1837) and Konstantin Konstantinov (1818-1871) made the greatest contributions toward the development of the gunpowder rocket in Russia as a weapon.

Zasyadko designed and tested a war rocket in St. Petersburg in 1817. The first rocket company was formed in St. Petersburg in 1826. Zasyadko's rocket was first used for war purposes during the Russo-Turkish war of 1828-29. Thousands of these rockets were also used during the war in the Caucasus. The war rocket designed by the British engineer Congreve was used in quantity in the war of 1812.

K. Konstantinov is claimed to be the founder of experimental rocket dynamics. He recognized the need for standardization so that his rocket was in all respects identical with the one manufactured previously. Konstantinov was aware of the necessity of scientific experimentation for perfecting rockets. He worked out in detail the methods of stand-testing of rockets by means of a ballistic pendulum of his own design.

Soviet writers are all pretty much in agreement, however, that Konstantin Tsiolkovsky is the father of modern rocketry. Tsiolkovsky (1857-1935) was a school teacher who, in his spare time, delved into the problems of aerodynamics, dirigible construction, reaction propulsion, and space flight.

Tsiolkovsky grasped the principle of reaction propulsion as early as 1883 but it was not until the close of the century before he created a mathematically precise theory of rocket propulsion. Many of the equations developed by him are still in widespread use today in the rocket field.

The most important contribution to science is his theory of the rocket relating to the mechanics of bodies with variable mass. The first type of long range rocket was described in Tsiolkovsky's work entitled "Investigating Space with Rocket Devices," published in 1903.

• Other developments—Comparable developments in the United States took place in 1916 when Dr. Robert H. Goddard, of Worcester, Mass., conducted his rocket experiments under the sponsorship of the Smithsonian Institution. Dr. Goddard published the results of his work in 1929 in a paper entitled, "A Method of Reaching Extreme Altitudes." He started work on a liquid fuel rocket engine in 1920 and the first flight of his liquid rocket vehicle took place on March 16, 1926.

The Russian efforts in rocket technology were accelerated in 1929 by the invention of a combustion chamber which would withstand high temperatures.

The Soviet rocket enthusiast, engineer F. A. Tsander, started to deal with rocket engines in 1908. Many interesting ideas on the improvements of rocket engines were proposed by Tsander in his book "Problems of Flight by Means of Reactive Apparatus," which was published in 1932.

In 1930-32 Tsander constructed two rocket engines—the OR-1 and the

---

**Research Laboratories Division, Bendix Aviation Corporation, Detroit, Mich.*

OR-2. The letter O comes from the word opytovyi meaning experimental, and R from the word for rocket or jet.

The OR-1 was constructed in 1930-31, and consisted of a combustion chamber, nozzle and pressurized feed system. The propellants employed were benzine and gaseous air which produced a thrust of 5 kg. (11 pounds).

The OR-2 was constructed by Tsander in 1932. The OR-2 used benzine and liquid oxygen for propellants with a nitrogen pressure feed system. The liquid oxygen was gasified before injection into the combustion chamber by means of a counterflow heat exchanger using hot water as a heat source. This unit produced 50 kg. (110 pounds) of thrust and was one of the first in the world to use liquid oxygen and petroleum fuel.

- **Propellants**—The Soviets did not overlook the importance of propellants in rocket propulsion. Yu V. Kondratyuk in his work "The Conquest of Interplanetary Space," Moscow, 1947, considered the question of using improved fuels such as lithium oxide and boron coupled with hydrogen and the metallic elements.

V. P. Glushko, who started work in the rocket field in 1929, suggested as early as 1930 the use of nitric acid, nitric tetroxide, tetranitromethane, hydrogen peroxide, colloidal fuels containing beryllium, and others as oxidizers and fuel.

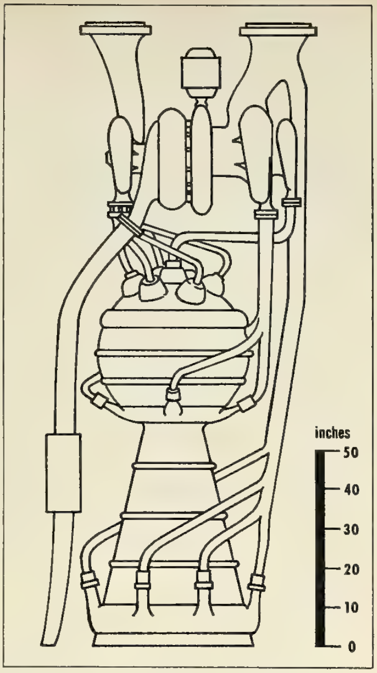
In the period from 1930 to 1936, the Soviet engineer Glushko designed and built a large number of liquid fuel rocket engines. In 1930 Glushko constructed and tested the ORM-1 liquid rocket engine. The designation ORM stands for opytnykh raketnýkh motorakh or experimental rocket motor.

The ORM-1 used nitric tetroxide for the oxidizer and toluol for fuel. In subsequent years Glushko produced many versions of his first design. In 1933 he designed and constructed the ORM-52, a 300 kg. (662 pounds) thrust unit using nitric acid and kerosene. An official test stand was designed for this motor.

The culmination of Glushko's efforts was the ORM-65 which he designed in 1936. This engine also used nitric acid and kerosene and produced a thrust of 155 kg. to 175 kg. (342-386 pounds). A specific impulse of 210 seconds was achieved with the ORM-65 unit.

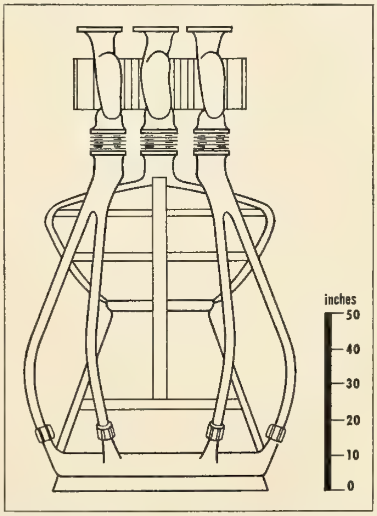
The ORM-65 engine was used in a soaring glider designed by S. P. Korolev and flown by F. A. Fedorov on February 11, 1939. It was also used in a winged pilotless vehicle, rocket 212, in the period 1937-1939.

Following the successful designs of V. P. Glushko, the Soviet engineer L. S. Dushkin produced a series of rocket engines in the period 1943 to 1945. These carried the designation RD and produced thrusts which varied from 651 pounds to 1980 pounds.



THE R-14 220,000-LB.-THRUST ENGINE. Note V-2-type spherical combustion chamber.

- **Post-war years**—The picture now gets cloudy. After the close of World War II, very little concrete information filtered through the Iron Curtain as to the efforts of the Soviets in rocket engine design. However, it is a good bet that the Soviets utilized to the utmost the German technology that they took over at the close of the war. A few pictures showing the German V-2 rocket being used by the Soviets have reached the press which bear out this conjecture. Undoubtedly, the Soviets have taken over and improved the V-2.



HOW RUSSIAN 600,000 pound thrust engine may look with dual fuel pumps.

A further source of information as to the Russian efforts behind the Iron Curtain has been provided by the German rocket technicians and scientists released from their stint of forced labor for the Soviets. These returnees have brought a few details on their own project activities from which it is possible to piece together a hazy picture.

Of great interest is the information on the R-14 rocket engine. Information has been provided on the R-14 rocket by German rocket collectives, who worked for the Soviets from the end of World War II to 1950. From this information it is possible to deduce the Soviet philosophy towards rocket engine design.

At the close of the war the Soviet's immediate goal was to standardize on propellants and gain performance through high-thrust rocket motors, high combustion-chamber pressures, and simplicity of design. The nozzle exit and throat dimensions of the R-14 have been calculated from the stated thrust and chamber pressure.

The R-14 engine would produce a thrust of 220,000 pounds with a combustion chamber pressure of 900 pounds per square inch. The 60-atmosphere system was to operate via a two-stage turbopump, while higher pressures would be developed by a three-stage system.

Fuel for cooling the nozzle walls, probably by transpiration, as used in the V-2 engine, comes directly from the fuel tank. The combustion chamber itself was cooled by fuel from the first stage pump, while the combustion chamber head was cooled by the output of the second stage pump. LOX as oxidizer and either kerosene or watered alcohol for fuel were probably the propellants.

Sources of information indicate a keen awareness by Russia of the importance of the rocket engine not only as a propulsion unit for meteorological rockets, IRBM's, ICBM's, and space vehicles, but also as adjuncts to fighter and bomber aircraft to achieve super performance.

The problems of liquid fuel rocket engine control are covered in Soviet text books which discuss not only the theoretical aspects but also the practical hardware aspects as well. The stress, placed by the Soviets, on the engineer's education in mathematics and especially non-linear mechanics, allows the design of extremely reliable and simple rocket engine control systems.

when and where

OCTOBER

1958 National Metal Exposition and Congress, American Society for Metals, Public Auditorium, Cleveland, Ohio, Oct. 27-31.

IRE 1958 Electronic Devices Meeting, Shoreham Hotel, Washington, D. C. Oct. 30-31.

NOVEMBER

Fifth Institute on Electronics in Management, American University, Washington, D. C., Nov. 3-7.

13th Annual Symposium on Applied Spectroscopy, Hotel New Yorker, New York, N. Y., Nov. 6-7.

Fifth Annual Meeting, Institute of Radio Engineers, Professional Group on Nuclear Science, Villa Hotel, San Mateo, Calif., Nov 6-7.

National Defense Transportation Association, 13th Annual Convention and Logistics Forum, Sheraton-Jefferson Hotel, St. Louis, Mo., Nov. 9-12.

School of Aviation Medicine, International Conference, Physics and Medicine of the Atmosphere and Space, Hilton Hotel, San Antonio, Texas, Nov. 10-12.

Society for Experimental Stress Analysis, 1958 Annual Meeting, Hotel Sheraton-Ten Eyck, Albany, N. Y., Nov. 12-14.

Conference on Scientific Information, AFOSR/Directorate of Research Communication, NAS, NSF and the American Documentation Institute, Mayflower Hotel, Washington, D. C., Nov. 16-21.

American Society for Quality Conference, Sixth Annual Aircraft and Missile Division Conference, Biltmore Hotel, Dayton, Ohio, Nov. 17-18.

American Rocket Society, 13th Annual Meeting and Astronautical Exposition, Hotel Statler, New York, N. Y., Nov. 17-21.

Eighth National Plastics Exposition, International Amphitheatre; and Plastics Conference, Hotel Morrison, Chicago, Ill., Nov. 17-21.

Northeast Electronics Research and Engineering Meeting, Mechanics Hall, Boston, Mass., Nov. 19-20.

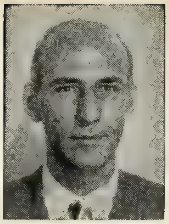
The Convertible Aircraft Congress, Franklin Institute, Philadelphia, Penna., Nov. 28.

First Electronic Computer Exhibition and Symposium, Olympia, London, England, Nov. 28-Dec. 4.

DECEMBER

Third EIA Conference, Reliable Electrical Connections, Dallas, Texas, Dec. 2-4.

Eastern Joint Computer Conference and Exhibit, Bellevue-Stratford Hotel, Philadelphia, Pa., Dec. 3-5.



propulsion engineering

by Alfred J. Zaehringer

Chemical-nuclear "hybrid" systems might allow a breakthrough in rocket performance before a practical all-atomic rocket arrives. Chemalco, a Pasadena, Calif. firm, suggests a slurry of a hydride (lithium, beryllium, or boron) in hydrazine. The slurry could be fed into a low temperature (2700°F) nuclear reactor to vaporize and exhaust the metal-fuel combination. Performance is estimated on the order of 350-450 sec.

Hot water rocket developed by German IPS has an I_{sp} of 50-60 sec. Water is electrically heated to a temperature of about 500°F under a pressure of 7,000 psi. When the water is released, the resulting steam expands to a velocity of 1,700 ft/sec. Dr. Saenger sees many ground-based RATO applications in Europe, since the system is cheap. A large hot water rocket developing 110,000 lb. thrust is planned.

Cryogenic liquid propellants will have to be tolerated, believes NACA, because they appear to offer the near ultimate in chemical performance. Much work, however, has to be done in storage and handling techniques before they can seriously be considered for operational use.

Plasma jet has been put to new use: depositing metals on various base surfaces. The jet developed by Giannini Plasmadyne Corp., for example, creates a plasma of 25,000°F with a velocity of 13,000 ft/sec. Tungsten coatings have been deposited on steel in this process.

Moly-coating process developed by Chromalloy Corp. appears to give an oxidation-resistant coat for molybdenum that may make the clad material a good bet for rocket motors. Chromalloy's subsidiary, Propellex Chemical, is reported testing the material for new, high combustion temperature composite and double base solid propellants.

Dispersions of metals and hydrides in plastic fuel-binders may be the answer to processing new high energy solid propellants. Such systems are safe to handle and use techniques long employed in the paint industry. One firm has already produced a dispersion of 50% solid high energy fuel material in a commonly used composite fuel-binder.

Solid propellant auxiliary power systems (SPAPS) are going into two solid rockets. Standard Oil Co. of Ind. has a thermoplastic fuel-binder composite that goes into the SPAPS on the *Falcon* rocket. AiResearch is to supply a SPAPS for the new *Nike-Zeus*. Solar Aircraft is studying SPAPS for use in 1000°F and in nuclear environments.

Nitration of ethylene glycol to form double-base solid propellant ingredient, DEGN, has been accomplished in a continuous flow-tube reactor by Hercules Powder. Scale-up of this system may be possible and may result in a new class of double-base solids.

Liquid monopropellant work at NARTS has hit an I_{sp} of over 200 sec at 300 psi. Composition of the high-density propellant was not disclosed. However, it is cheap, can serve as a coolant in regenerative motors, and is easy to store. Big problem appears to be high shock sensitivity.

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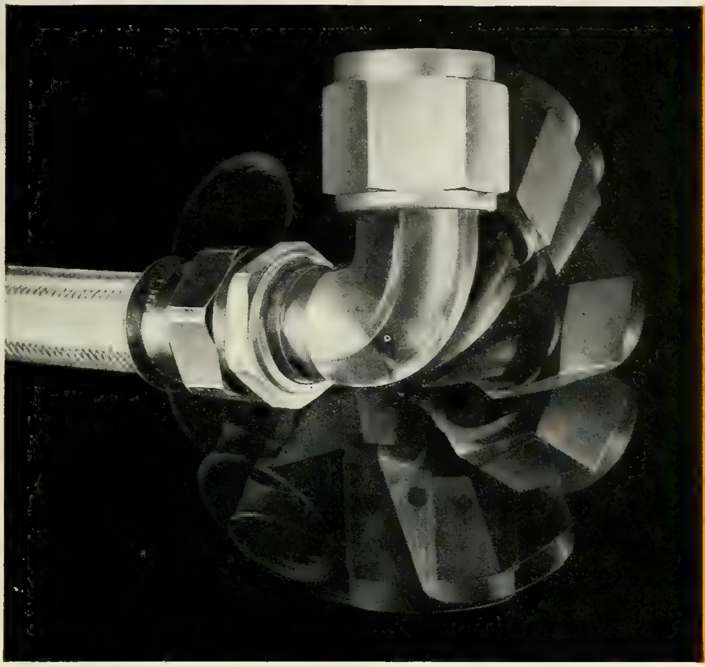

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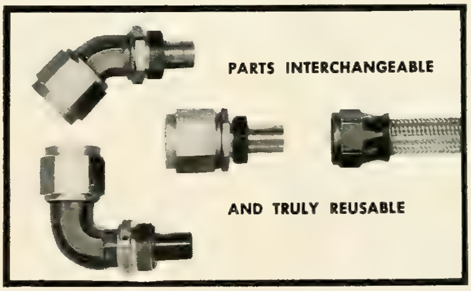

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Boeing Starts Work On ICBM *Minuteman*

Half-billion dollar missile replacing B-52 production; bolsters U.S. defense concept

by Clarke Newlon

WASHINGTON—Last year when Boeing lost out to North American in the competition for the long range supersonic bomber (Weapon System 110, later designated the B-70), President William Allen's wrath shook the big Boeing complex from assembly line to executives' row.

At the time Boeing entered into the competition for the second generation ICBM *Minuteman,* it was generally understood that heads would roll if Boeing lost. With the B-52 phasing out and only commercial aircraft on the horizon, Boeing was in the missile business up to its apogee and the *Minuteman* contract conservatively would run half a billion dollars before production.

When the Air Force announced the winner of the competition (m/r Oct. 20, p. 14) Boeing heads were safe. The Seattle Company had won the assembly and testing contract over 13 major competitors, reportedly by a narrow margin but by unanimous decision.

Boeing started work immediately in production preparations for another project in a long history of company "majors." However, a problem: shop space. With the B-52 program apparently ending in February, the high bay areas which formerly accommodated the towering tail assembly of the SAC bomber would be available for the 50-plus foot height of the *Minuteman.*

Boeing officials went into swift huddles with executives and production people from subcontracting companies named months ago—Avco for the nose cone; Autonetics Division of North American for guidance; Thiokol and Aerojet, who are backing each other up on first, second and third stage engines; and Hercules Powder, which is exploring a double-based propellant potential, probably ammonium perchlorate.

By February the assembly line reportedly will be laid out and the contracted components, let last July under a source-selection competition, will arrive at Boeing to be run through the line in mockup.

Competition Schedule

Seventeen companies invited to bid Spring of 1958. Fourteen bids received, late summer. Bids went to Source Selection Board (including AMC, ARDC, SAC) in September. Board deliberations completed about September 30. Command briefings held September 29-October 3. Board and Command recommendations returned October 6. Recommendations made to AF Chief of Staff and AF Secretary, October 7. Recommendations made to Deputy Defense Secretary Quarles, October 9. Unanimous decision reported for Boeing, October 10, 1958, with Boeing officially notified that date.

Air Force considers its first two intercontinental ballistic missiles—the Convair *Atlas* and the Martin *Titan*—to be first generation weapons, the "Model T's" of the family. Compared to previous aircraft-type weapon systems for the U.S. retaliation-defense concept, they are more expensive to build and each new change—there are many as the state of the art progresses—means major revisions. This includes launching and maintenance equipment and perhaps a retraining of personnel manning the weapon.

Therefore, missilemen believed that if developments came along particularly in the guidance and propulsion, it conceivably would be simpler to create a new weapon than to try and convert existing ICBM systems. That's the why of *Minuteman.* However, this does not mean *Atlas* and *Titan* will not be used; they are hardware in being, available—or almost—now. *Minuteman* promises to be ready in the 1961-62 zone.

Quick development—

In its short history, *Minuteman* is one of the fastest drawing board developments of any major military vehicle. Considering the first two ICBMs, the Air Force wanted these requirements for the follow-on:

(a) Simplicity, little expense and so basic in design it could assimilate new developments for the next 10 to 20 years without altering the original concept. It should be able to accept new fuels as developed, an improved guidance system or a multiplicity of shapes and sizes of warheads;

(b) It should eliminate countdown with a solid fuel able to fire like a rifle;

(c) It should have no on-site maintenance with the missile dropped into its "sunken silo" base, to be serviced by automatic (or semi-automatic) checking apparatus, where it would stay for its operative life, perhaps as long as a year before it would be replaced and returned to the factory for disassembly and/or rebuilding;

(d) Launch sites would be hardened to 100 pounds pressure per square inch or more; the control points further hardened, missiles cross-controlled from at least three points and the entire complex so dispersed that one nuclear hit would not knock out more than one site. Ideally, the sites might be strung along a highway, as in this week's m/r cover conception, or along a railroad.

Military objective—

The man who came up with the answer to these requirements was Colonel Edward N. Hall, of the AF Ballistic Missile Division in Los Angeles. He later was made project officer, and his vocal, firm opinions pushed the project through in short time. The accompanying "timetable" box amply confirms this. The "Father of the Minuteman" is now assigned as the staff missile advisor to the U.S. Mission to NATO.

Back of the *Minuteman* program is the military planning concept that Russia will start hostilities when she is convinced that she can destroy the American capability to wage war and still sustain the losses the U.S. and her allies would inflict.

Suppose, for example, that the USSR could reach the point where her forces were capable of knocking out two-thirds of America's retaliatory force.

The one-third which remained could still devastate the Soviet. But it might not be able to knock out the Soviet offensive force to the extent ours had suffered, because Russia would have had the initiative—surprise—on her side. In a continuing struggle, Russia would eventually win because of remaining superior military forces, especially true even if Russia would disperse her military forces and civilian populace outside target areas.

U.S. concept—

It is possible to visualize a situation where the Soviet government, with this obvious military superiority, would simply invite observers, point to her overwhelming military force, dictate her terms and win a total victory without firing a missile or sending a plane aloft.

But the U.S. concept is inherently tied to the present massive struggle of cold war, with both countries fighting for supremacy, first in manned bombers, and now in missiles—whether sea or airborne, and whether land, sea or air-launched. And preparations today will decide the future in a contest on whom will be first with military machines in space.

All U.S. military planning—NATO strength, dispersed SAC bases, Army atomic capability, *Polaris* submarines—has this objective—to be sure that Russia does not reach a point wherein she feels strong enough, vis a vis the U.S. military team, that she could accept the losses of an all-out war. This is the present strategic concept and posture of the U.S. and her allies.

This concept and posture is relatively simple—to have retaliatory forces so strong, so varied and so dispersed that Russia cannot hope to knock them out effectively.

The retaliatory concept is the reason for SAC bomber bases in Spain, North Africa and Britain and for Britain's own atomic bomber capability. It is the reason for nuclear-capable fighter bases, with ranges far behind the Iron Curtain. It is the reason for ground forces with atomic artillery in the NATO line from Turkey to Norway. It is the reason for nuclear-capable fighter planes on our aircraft carriers, for atomic submarines, for *Jupiter* and *Thor, Atlas* and *Titan, Polaris* and *Minuteman.*

There undoubtedly have been attempts for good reasons and obvious misjudgment errors—to make the four major U.S. missiles—*Atlas, Titan, Polaris* and *Minuteman*—competitive with each other. But military planners do not so regard them. True, *Atlas* and *Titan* are in a sense competitive, but only because one is likely to enter the inventory, according to present planning, as the other fades out. Neither, again according to planning, is really competitive with *Minuteman* because it is designed for different atomic-capability targets. (*Atlas* and *Titan* have much larger warheads).

Polaris and *Minuteman* have a common characteristic—solid-fueled—and a dual role in the U.S. strategic concept. One to be fired 1,500 miles from dispersed and possibly submerged submarines. The other is designed to be fired from dispersed holes in the ground and will cover a range of 5,500 miles.

ICBM value—

Minuteman's value to the strategic picture lies in its relative cheapness (reportedly one-seventh of *Titan* or *Atlas*); the reported ease of hardening its sites and the reported low personnel requirements (20 per site as opposed to several hundred for *Atlas* or *Titan*). Time will prove the concept right or wrong.

But in *Minuteman* studies, literally hundreds of situations and presumptions have been theoretically evaluated, taking into account multiple changes in the basic factors, i.e., numbers of weapons, force of weapons, probably target error and the degree of hardening possible or desirable. Paramount consideration has been that in a few years the Soviet will possess a ballistic missile force of multi-megaton power, capable of 4,000 or more miles of flight with a two-mile radius of target error. (Four thousand miles probably is all Russia needs to cover the U.S. The U.S. however, needs another 1,000 miles or more to cover the Soviet).

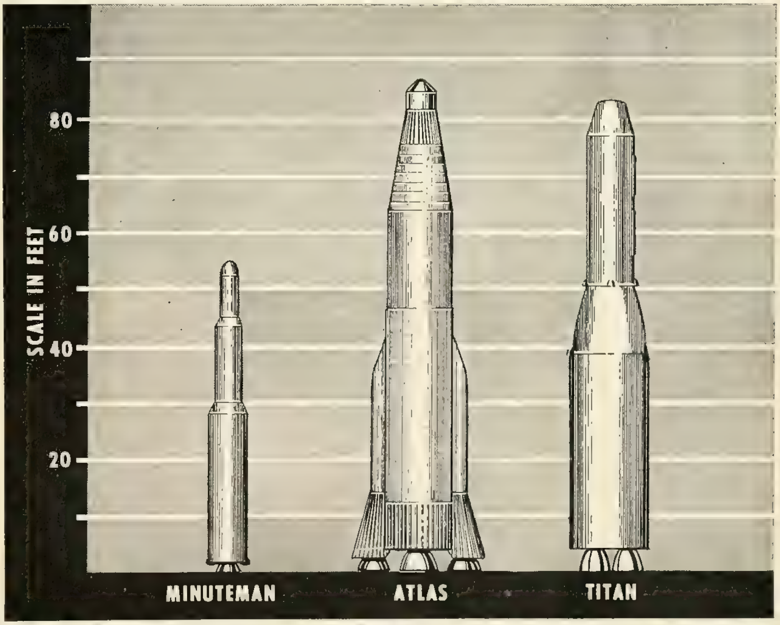
Other studies show that Russia would have to assign a relatively small (say X number) of missiles to be reasonably sure of achieving 90% destruction of any "soft" U.S. ballistic launching site.

But the Russians would have to send over some 30 times as many missiles (or 30 times X) to be sure of neutralizing a missile site which was both dispersed and hardened to the point where it could withstand a blast force of 100 pounds psi.

Multiplying this 30X figure by 100 or perhaps 1,000 or more sites in this country indicates the difficulty of delivering an effective knockout blow.

And while Russia is knocking out *Minuteman,* she has to deal with *Polaris,* with the *Jupiter* and *Thor* sites in Europe, with SAC's nuclear strategic bombers and fighters, with the Navy's nuclear fighters and the Army's atomic capability—all strong, varied and dispersed. While the U.S. problem is great, Russia's is not easier.

How ICBM's Compare



TOMORROW'S MINUTEMAN seems small in comparison beside ***Atlas*** **and** ***Titan.***

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Precise Measurements Sought For Space

by Raymond M. Nolan

WASHINGTON—Now that the U.S. has finally gotten an object farther out in space than the orbiting satellites, the measurement of things once taken for granted—time, the meter bar, kilogram, and temperature scale degree—is assuming new importance.

Probably most important is the measurement of time. The U.S. Naval Observatory in Washington, responsible for the official determination of time in the U.S., now determines time by counting the vibrations of crystals kept in a scientifically-designed location. The vibrations are then checked on a daily basis against the earth's rotation.

However, this unit of time, while adequate for most things, will not be precise enough for space travel when a fraction of a second of error might mean that a resupply vehicle would miss its rendezvous with an orbiting station or another vehicle.

The variations in the length of a second, almost imperceptible, are caused by measuring methods. Since the length of the solar second depends on the time it takes the earth to make one complete revolution and since the earth is gradually slowing down, the second, as seen by scientists, is a shifting value. At least shifting in a sense that a variation of one-millionth of a second might someday become intolerable.

Because of this problem, quite a bit of attention has been given in recent years to an atomic method of determining time. This work has resulted in a commercially-available atomic clock manufactured by the National Co. of Malden, Mass. and various atomic timekeepers developed by companies for their own use. Actually, it goes even farther than that—the Naval Observatory now makes daily comparisons of its time determination with an atomic clock in the Naval Research Laboratory in Washington.

• **Measurements**—The atomic clock operates on the principle that the cesium atom gives off waves of energy with a constant frequency over a period of time, regardless of outside influences. This radiated energy can be counted to a high degree of accuracy. Scientists are measuring time with atomic clocks with an error in the neighborhood of 5 ten-billionths of a second, or one second in 60 years.

However, there is hope that this accuracy can be increased by a whole order of magnitude in the next few years. Solar time at the present has a maximum accuracy of plus or minus one second in 30 years.

The National Bureau of Standards' Boulder, Colo., facility has been using an atomic clock for a year to measure time and standard radio frequency. Time signals are set by the atomic device.

Time is not the only measurement under scrutiny. The National Bureau of Standards and many commercial firms are seeking ways to more accurately measure other standards. Besides the solar second, the other three primary standards from which all other measurements are taken are: the national meter bar (a copy of the international meter bar kept in France), the national kilogram, and the international temperature scale degree.

Weights and lengths used now are derived from long-standing Congressional Acts. The National Bureau of Standards is responsible for determining the conversion factors between the units we use and the four primary standards. Other standards for radio waves, electricity, atomic radiation and magnetism are kept by the Bureau, but while it is possible to measure these by conversion from one or another of the primary standards, the Bureau, in fact, does its measurements with a set of instruments that reproduce the derived standards.

Temperature measurements have been of interest to the Bureau for many years and some outstanding work has been done on measurement of extremely high and extremely low temperatures. Some discussion of this problem appeared in Congressional testimony this year and was probably responsible for this year's direct appropriation of $11.5 million, up $2 million from fiscal year 1957.

• **Pertaining to missiles**—Experiments underway at the Bureau and throughout industry are aimed at the redefinition of the meter by means of the length of certain wavelengths of light. Since light waves are now being measured down to something like a ten-millionth of an inch, the national meter bar could have its length checked ten times more accurately with light than is possible now.

This determination of length is important to the missile industry, where tolerances now are "intolerable," in the

Sidewinder Production Line . . .

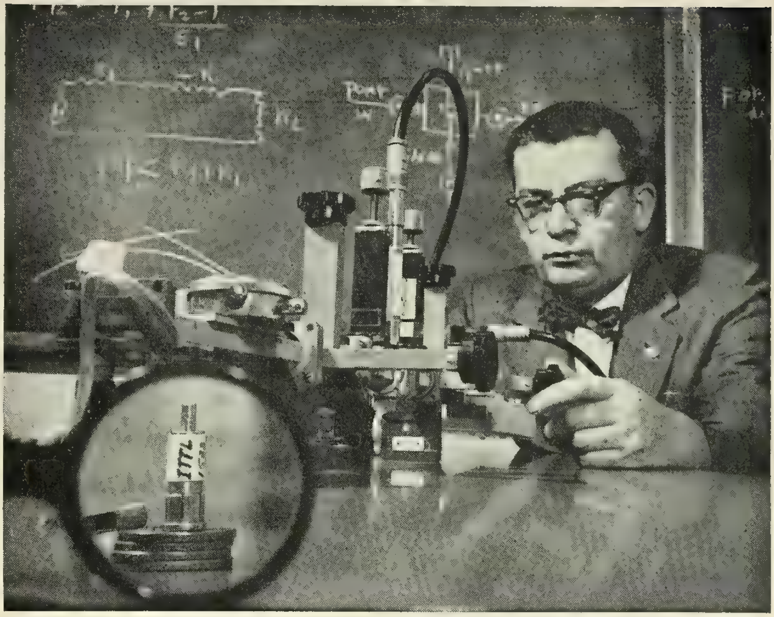
GUIDANCE AND CONTROL sections of the *Sidewinder* missile in final checkout before shipment by Philco. This is first *Sidewinder* production view released by the Defense Department. Missile is used by Navy's Sixth and Seventh Fleets and by AF F-104A.

words of one missile maker's production manager. In the guidance field particularly, gyros have become so precise that they are designed to be built with more accuracy than any available laboratory measuring instrument. Weight is a serious problem with gyros because of their dependence on mass for gyroscopic action.

Standards laboratories are becoming a necessity for almost all large corporations because of the multitude of precise measuring instruments that must be kept in perfect calibration for precision manufacturing. Some companies have gone even further and are doing basic research in standards determination. Much of this is concerned with the determination of length but several laboratories also have tackled the weight and temperature problems.

• **Space Age measurement**—Some of the larger corporations active in the standards field are American Telephone and Telegraph, International Telephone and Telegraph, Radio Corporation of America, Sperry Rand Corporation, Minneapolis-Honeywell, General Electric, and Westinghouse.

Silicon Diode Used in Parametric Amplifier . . .



A sub-miniature silicon diode (magnified section of photo) is the heart of a recently announced parametric amplifier developed by the International Telephone and Telegraph Corp.

Immediate application of the new low-noise amplifier will be the extension of scatter and microwave radio links by 25 or 30% or the lowering of transmitter power for the same distance by as much as 90%. Combinations of decreased power and increased distance also may be used.

ITT sees eventual applications of the amplifier providing substantial savings to commercial and military users of over-the-horizon communications by reason of lower power consumption, less expensive equipment and greater distance per link.

In a technical description of the amplifier, William Sichak, director of the Radio Communication Laboratory at ITT, said that a received microwave signal with a frequency of 900 megacycles is modulated in the amplifier with a 9900 mc output of a local oscillator, producing a resultant 9000 mc output with a conversion gain of 18-20 db. This 9000 mc signal is then mixed with a 9070 mc local oscillator signal in a standard crystal converter, producing a 70 mc IF output. The overall noise figure is less than 1 db, compared with a figure of somewhere around 8 db in existing systems.

The first use of the new amplifier is for telephone conversations, television programs and communications systems but future uses for long range radio links in the missile field are in the offing.

Electronics Field Soars to Worldwide 5th Place

The future of electronics as a science is "forewritten," and it has grown twelvefold since World War II. Today, it is the fifth largest business in the world, surpassed only by petroleum, automotive, meat packing and aircraft. These facts were cited by Maj. Gen. J. B. Medaris of Army Ordnance Missile Command recently.

Of the $39.1 billion defense expenditures in FY 58, the estimated almost $41 billion this year and $44 billion in 1963, a good percentage will be in the electronics field. Last year's more-than $7 billion in electronics expenditures is expected to double by 1963, with considerably more than half going to defense electronics expenditures. Importantly, these figures do not include R&D where electronic laboratory and test equipment will add an impressive amount to the totals.

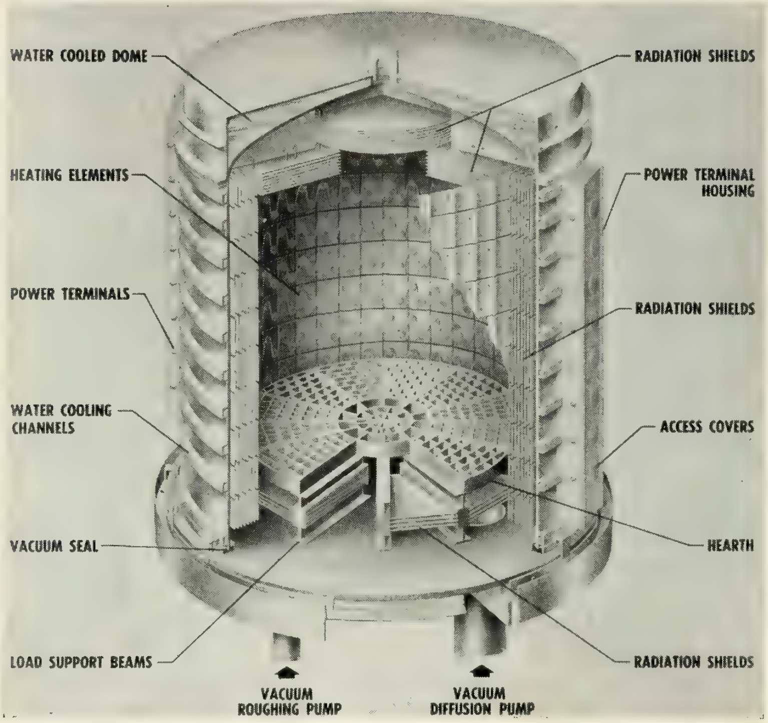
Propellants and propellant checkout systems now account for a good part of the missile bill, but when ion and plasma propulsion schemes become a reality, then these too can be counted as electronics, fattening the amount still further, General Medaris said. Initial nuclear propulsion units cannot rightfully be included in any electronics totals, but when controlled thermonuclear fusion becomes the power source, it too will probably fall within the description of electronics.

His remarks are significant because the most important area for large expansion in the electronics business hinges on a yet-to-be realized breakthrough—new ways to develop electrical power. Every plan for manned and unmanned spaceflight today has the drawback of almost impossible to achieve power requirements. Many scientists feel that, until power can be obtained from other than conventional sources, exotic forms of propulsion and crew environment will remain as major stumbling blocks.

Conversion of solar energy to electrical power is a reality, but the amount of power developed in relation to the size of the required equipment does not make solar conversion attractive in its present state. Another method being investigated by quite a few companies is the Peltier effect (m/r October 13 page 39), where different temperatures of dissimilar metals produce a flow of electricity. But here again, efficiencies are low and capacity is limited by size requirements.

If and when the breakthrough occurs, it will almost certainly come as a result of research and development in space technology, but its applications will be so universal that some observers feel it will more than justify any amount of money pumped into it.

At any rate, the electronics industry is riding pretty nicely on a healthy growth curve and can expect to remain in this position for some time. But, if a breakthrough in power development occurs, throw away the old figures—they'll be meaningless.



GE Vacuum Furnace Insulated with Metal

Quick heat-up and cooling cycles for heat-treating super alloys of stainless steel and refractory metals, such as titanium and zirconium, is possible with a new electric bell-type furnace developed by General Electric Company.

Cylindrical metal shields instead of brick insulate the inside walls. The furnace casing is water-jacketed to keep it cool, making it possible to retain strength to withstand atmospheric pressure with high-temperature work loads. Losses due to convection are reduced by the vacuum in the furnace. A protective gas atmosphere can be used in the furnace while it is in operation.

The metal radiation shields form a complete enclosure around the material being heat treated, retarding radiation heat losses. The alloy shields are arranged in several layers of concentric cylindrical shells on the inside walls of the heating chamber, and the top and bottom have separated layers of alloy sheets in a horizontal position.

New Radio 'Scope Has High Resolving Power

A new type of radio telescope, believed to be the largest of its kind in the world, is in partial operation at Stanford University even though construction is only at the half-way point. The telescope, which has been under construction for the last three years and is expected to be completed in about six months, is financed by grants from the U.S. Air Force Office of Scientific Research.

On completion, the telescope will possess the highest resolving power, or focal clarity, of any radio telescope in the United States. The resolution is expected to be equal to that of a steerable paraboloid with a diameter of 375 ft.

The completed portions of the telescope include sixteen solid aluminum "dish" antennas, each 10-feet in diameter and mounted on a concrete pedestal, lined up in a 375-foot row across Stanford campus.

The antennas are synchronized to move in unison, probing the sun's blazing atmosphere with what is described as spectacular precision.

The system is expected to play an important role in the study of other planets in space which some day will be probed by man from space vehicles. When completed, the telescope's beam will be only 1/15th of a degree in both dimensions.

Computer Symposium Programmed for Chicago

The fifth annual Computer Applications Symposium, sponsored by Armour Research Foundation of Illinois Institute of Technology, will be held at the Morrison Hotel, Chicago, October 29-30.

The conference will have a different emphasis each day. On the first day, business and management applications will be the subject in sessions, and on the following day, the symposium will deal with engineering and scientific areas.

On the morning of the first day, Col. D. E. Ellett, chief of the data development division, directorate of plans and programs, Headquarters, Air Materiel Command will have as his subject, "Information Systems Modernization in the Air Materiel Command."

On the second morning session, the program lists "Scientific Uses of a Medium-Scale Computer with Extensive Accessory Features," R. A. Haertle, AC Spark Plug division of General Motors; "Optimizing Designs with Computers," D. D. McCracken, Institute of Mathematical Sciences, New York University; "Computer Applications in the Numerical Control of Machine Tools," R. B. Clegg, Kearny & Trecker Corp.

In the afternoon session, the program includes "Computer Sharing by a group of Consulting Engineering Firms," E. M. Chastain and J. McCall, Midwest Computer Service Inc.; "Current Developments in Computer Programming Techniques," F. Way III, Case Institute of Technology; "The Future of Automatic Programming," W. F. Bauer, Space Technology Laboratories.

Fred J. Gruenberger, mathematician of the RAND Corporation will chair the October 29 session and C. B. Tompkins director of numerical analysis research in the department of mathematics at the University of California at Los Angeles will be chairman for the October 30 session. At the close of the program each day, the chairman and speakers will conduct a roundtable discussion.

Two lunches are scheduled. On the first day, C. A. Phillips director of the data systems research staff of the Assistant Secretary of Defense (Comptroller) will have as his subject, "Problems and Prospects of Data Processing for Defense." On October 30, the speaker will be R. W. Hamming of the Bell Telephone Laboratories technical staff, who will speak on "Frontiers in Computer Technology."

A welcoming speech to registrants will be given by Dr. Haldon A. Leedy, director of the Armour Foundation.

missile business

There are no panaceas in the Pentagon now to cure the ills of small percentage participation by small businesses in the $6 billion-plus missile field.

But under the powerful watchdog eye of the Senate Select Committee on Small Business, the pressure is on for DOD to do more than just say it is aware of the problem.

The problem is basic: Small concerns can make valuable contributions to the nation's missile progress, but they are not being effectively utilized under the weapons system concept. In the field of research and development, small business participation is particularly needed.

The committee has recommended that the still-to-be appointed DOD Director of Research and Engineering designate an individual in his office to assist small firms in R&D contracting. If this is done, it should provide a healthy atmosphere with direction coming from the top, which the committee says is necessary. But, according to the committee, there are other areas that need correcting:

1. Lack of adequate specifications and drawings which can be "farmed out" to insure maximum open bidding.
2. A dearth of DOD-sponsored information on missile programs at the prime-contractor level available to the small supplier. Areas not sufficiently stressed include procedure for security clearances, types of contracts being utilized, end items desired, and what funds will be expended.
3. Less tendency of missile primes to consolidate their subassembly requirements and the subsequent placing of orders with large or medium-sized contractors instead of small business.

Speaking of small concerns, before Congress adjourned it voted a change in the Tax Code that will be important. Under certain circumstances of Public Law 85-866, small concerns can get the benefits of a corporation without getting double taxation of profits.

"There's a definite need for the government to distinguish between good and bad performance of contractors," Lt. Gen. E. R. Quesada (USAF Ret.), said. "Both continue to receive contracts and there should be," Quesada added, "some criteria established between good and poor performance."

Advanced Research Projects Agency—with a budget of some $420 million in fiscal year 1959—wants, and is anxious to do business with anyone who has a good military space proposal. That's the word from Rear Admiral John E. Clark, deputy director, who spoke last week to the National Rocket Club. Clark explained that ARPA—which has far-reaching contract authority—wants to insure that any industry gets a fair hearing.

Industry Roundup: Genisco, Inc., of Los Angeles, manufacturer of missile components and testing equipment, has acquired all of the capital stock of the **Eldema Corp.** of El Monte, California . . . A construction contract will be let next month for an $8-million addition to **Lockheed Missile System Division's** Sunnyvale plant. The facility will be used for WS-117L satellite development . . . **Bristol Aeroplane Co.** and **Aerojet-General** have formed a subsidiary company—Bristol-Aerojet, Ltd., with a factory in England, and will pool their solid rocket motor techniques . . . **Telemeter Magnetics, Inc.** of Los Angeles has leased additional space and plans to expand employment by 20% before the end of the year . . . **Titeflex, Inc.,** of Springfield, Mass., has established a Pacific Division in Santa Monica, Calif. . . . Dow Chemical Company has reported net income of $11,175,730, or 43 cents per share of common stock outstanding, for the first quarter ending August 31.

contract awards

ARMY

By U.S. Army District Engineers, Los Angeles Corps of Engineers:

Noxon Construction Co., Los Angeles, received $126,022 for facilities for launch control and safety (IRSS) Skyscreen Roads, camera pads and utilities at Vandenberg Air Force Base.

By Cleveland Ordnance District, Cleveland:

Norman Noble, Inc., Cleveland, received $43,755 for nozzle support weldment for *Jupiter* missile.

By Headquarters, Quartermaster Research & Engineering Command, U.S. Army, Natick, Mass.:

Princeton University, Department of Chemistry, Princeton, N.J., received $32,800 for study of the preparation and properties of monodisperse polymers.

By District Engineer, U.S. Army Engineer District, District Albuquerque, N.M.:

George A. Rutherford, Inc., Albuquerque, N.M., received $246,731 for White Sands Missile Range, N.M.

By U.S. Army Ordnance District, Los Angeles, Pasadena, Calif.:

Douglas Aircraft Co., Inc., Santa Monica, Calif., received $41,611 for repair parts.

General Electric Co., received $168,591 for computation facility operation.

Aerojet-General Corp., Azusa, Calif., received $49,964 for design and study.

Aeronutronic Systems, Inc., Glendale Calif., received $134,883 for orbit determination.

Aerophysics Development Corp., Santa Barbara, Calif., received $74,932 for feasibility study.

By U. S. Army Ordnance:

Telecomputing Corporation, Los Angeles, has received an add-on contract of $1,510,637 for nuclear warhear test equipment.

By Redstone Arsenal:

Firestone Tire & Rubber Co., Guided Missile Division, Los Angeles, received $34,627 for furnishing 24-man-months of technical services of engineers, for training groups of military and other personnel.

Teleprompter Corp., New York, received $200,000 for providing technical assistance in operation, maintenance and supervision of closed circuit television and teleprompter equipment, and producing and telecasting programs for the training schedule of the Ordnance Guided Missile School.

AIR FORCE

By Commander, Headquarters AMC, Wright-Patterson Air Force Base, Ohio:

Extrusions, Inc., Caldwell, N.J., received $85,780 for development of a process for the extruding of titanium and steel alloys by use of explosives.

By Air Force Cambridge Research Center:

Sylvania Electric Products, Inc., Waltham, Mass., received $48,707 for study of electromagnetic and magnetohydrodynamic properties of ionized gases associated with high-speed missiles.

ABMA Transfer to NASA: Good or Bad?

by Erik Bergaust and
William O. Miller

WASHINGTON—A move by Administrator T. Keith Glennan of the National Aeronautics and Space Administration towards exercising transfer powers authorized by the National Aeronautics and Space Act without advice of a still-to-be appointed civilian-military liaison committee has touched off a controversy extending to the White House.

The controversy—as forecasted by m/r (Oct. 13, p. 9)—developed when Glennan reportedly proposed to Army Secretary Wilber M. Brucker that the Army Ballistic Missile Agency's team of scientists, headed by Dr. Wernher von Braun, be transferred to the administrative control of NASA.

The request was made without the prior knowledge of the Army's top missile men, both in Washington and in Huntsville. The Space Act specifically calls for appointment of a civilian-military liaison committee, which if it had been operating when Glennan made his proposal, would undoubtedly have obviated much of the confusion and protest. It is expected that the next meeting of the National Aeronautics and Space Council on October 28 will see the belated appointment of this committee.

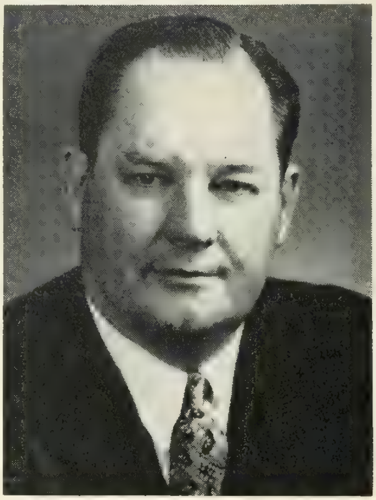
The President will appoint the committee chairman. Defense Secretary McElroy will name representatives from each of the three military services and Glennan will make a like number of appointments from his agency.

Much of the controversy stemmed from the lack of details of the NASA proposal. Glennan will not comment on it and the President has declared that he will make the final decision. Key questions unanswered are how many and what personnel are to be involved, what facilities will be transferred, and, most important of all, how will the transfer affect Army missile programs?

However, time enters into the problem. The power of the President to transfer facilities and manpower will be subject to approval of Congress after December 31. The question arises whether the lawmakers will stand still for action taken by the Space Council.

In fact, Congress has a club if it wants to use it. Of the nine members appointed to the Council, two were recess appointments and must be confirmed by the Senate. They are William A. M. Burden, New York investment banker, and Lt. Gen. James H. Doolittle, retired. Doolittle will become chairman of the board of Space Technology Laboratories January 1. Doolittle's appointment may be debated for possible "conflict of interests," because of his STL position.

Two other members appointed were Dr. Detlev W. Bronk, president of the National Academy of Sciences, and Dr. Alan T. Waterman, director of the National Science Foundation.


NASA's KEITH GLENNAN—his move angers Army scientists.

Other members are the President as the chairman; the Secretary of State, the Secretary of Defense, the Chairman of the Atomic Energy Commission, and Glennan. These men will assist the President in making the decision regarding transfer of the Army team.

- **Army indignant**—The Army brought in its big guns in an attempt to block the move, or at least to find out what actually is involved in the proposed transfer.

Maj. Gen. John B. Medaris, commander of the Army's Ordnance Missile Command, flew from Chicago to Washington, reportedly to seek an appointment with the President. While he did not see him, he conferred with Secretary Brucker.

Even though they would not be quoted, top Army officials voiced fears that their missile agency might become nothing more than housekeepers supplying support to the civilian agency. This, they said, would undermine the Army's missile program to the detriment of the national defense.

- **German scientists speak**—German scientists, heart of the Huntsville team, spoke out in no uncertain terms:

"Such a transfer would seriously damage the Army's capability to fulfill its weapon systems requirements," one scientist said. He pointed out that replacement of weapons would require a period of several years and would cost over $100 million. Splitting the team up would not be effective utilization of personnel, who have repeatedly proved their ability to carry out missile and space programs, he added.

Army's major concern is that transfer of part of the team, which has a strong group loyalty, would result in many leaving the Army and NASA for higher paying positions in industry.

As one German scientist put it: "The proposal would involve transfer of U.S. citizens who have verbally stated their opposition to it. There is no logical reason for the transfer since the Army organization is willing to support NASA in the same way it has supported the Advanced Research Projects Agency in DOD."

Another said: "The interconnection between missile development and space exploration activities at ABMA is so intimate that both could come to a screeching halt if the existing team is broken in two. If this happens, it would do the most serious damage to the defense effort of our country and our attempts to regain technical superiority in the space age.

"Our work has been most important for tactical purposes in the military field and in the technical and scientific fields and we feel we have contributed to both. Such a split would be extremely inadvisable and undesirable. Our country cannot afford to do this at the present time."

- **Thousands involved**—"The core of ABMA is the development operations division, headed by von Braun. The division has 3,925 employees led by a team which has no equal in the world," an Army spokesman explained. "They have worked together as a team in this country since 1945, and in their firsthand knowledge in developing, assembling and firing over 400 ballistic missiles they have ten times the experience of any other U.S. missile group. Of the total number, 1,249 are scientific and professional personnel, the Army spokesman added.

AUSA Avoids ABMA Transfer

by **Donald E. Perry**

WASHINGTON—The two most significant impressions coming from the 1958 meeting of the Association of the United States Army (AUSA) were gained from things that weren't officially said. There was absence of any mention of the proposed transfer of Army Ballistic Missile Agency (ABMA) to the National Aeronautics and Space Administration (NASA) and the discussed possibility that Army may be on its way to losing its coveted missile capability.

All discussions avoided the ABMA transfer. But it was the most popular subject wherever two or more people met—in the hallways, in hospitality suites and even the exhibit hall where conventional weaponry was heavily stressed. As one observer jokingly commented: "There are too many vacancies open in Panama."

Both the opening speech by Vice Chief of Staff General Lyman L. Lemnitzer and the remarks of JCOS Chairman General Nathan E. Twining, low-rated missiles and other new weapons as factors in increased Army mobility and firepower.

General Lemnitzer said that while the layman considers the missile age as basically altering the conduct of war, missiles have their shortcomings. "While they contribute to meeting aggression, they do not, however, improve our ability to maneuver, to exploit firepower and to occupy and deny ground," he said.

"New weapons will justify reductions on Army firepower only in those types of forces where the primary function is to achieve destruction by heavy firepower," he continued. "Army forces benefit only from missiles to a limited degree, through the replacement of heavy non-atomic artillery and reduced close air support requirements. Army forces gain nothing from these particular items in terms of mobility or of the ability to occupy and deny ground."

General Twining told his audience that he thought Army emphasis should be on firepower and speed with the majority of combat equipment capable of movement by air or fast ship.

"When I speak of mobility," he said, "I am thinking of both rapid movement and fast reaction. The *Redstones*, *Corporals* and even *Honest Johns* of today are not really mobile in the sense of rapid movement in a battle area. Nor do they yet possess the capability for fast reaction. Firepower is not much good unless it can be applied quickly and flexibly. Emphasis must be placed on insuring improvements in these characteristics in the follow-up models such as *Pershing* and *Sergeant*."

Both Twining and Lemnitzer said the answer to successful development of the weapons needed is in the close cooperation between the services and industry. Lemnitzer added that science and industry are basic to the process of research and development, test, standardization and procurement.

A panel discussion of the Army's achievements in larger missiles and in space research included such participants as Lt. Gen. Arthur Trudeau, Army Chief of Research and Development, chairman; Maj. Gen. John B. Medaris, AOMC; Dr. Ernst Stuhlinger, ABMA and Brig. Gen. Frederick W. Gibb, commander of the Combat Development Experimentation Center.

In prepared texts, no mention was made of the proposed transfer of ABMA. Discussions were general, with emphasis on the research and scientific achievements made by the Army's team—that portion of the Army program NASA would like to have transferred to the civilian agency.

De-emphasis of missiles and rockets apparently was not accidental, but came from action of the AUSA board which reviewed speeches. Search for a new Army theme was said to be the motivation.

If the AUSA 1958 convention is any yardstick, the Army is far from leaving the infantry concept behind. The meeting reinforced the Air Force claim that the Army can take care of tactical situations with a combination of men and small missiles, while the USAF concerns itself with strategic policy.

New Hot-Cold Light Panel Has Space Use

PITTSBURGH—The first experimental model of a three-purpose combination hot-cold light panel was revealed here last week by Dr. J. A. Hutchison, vice-president in charge of engineering and research, Westinghouse Electric Co.

The experimental panel combines into a single operating unit two of man's newest technological advances—thermo-electric refrigeration and electro-luminisent lighting. Thermo-electric refrigeration produces cooling in special solid materials directly from the flow of an electric current. Electro-luminisent lighting is produced by glowing panels, no thicker than a sheet of ordinary windowglass.

The new foot-square hot-cold light panel, composed entirely of solid state materials, has no moving parts. It produces as much light as a 25-watt light-bulb, can maintain a surface temperature approaching that inside a house-hold refrigerator and can raise the surface temperature to about 130° F—a temperature suitable for radiant heating.

Dr. Hutchison told m/r he could visualize that the hot-cold system might be used in satellites and space vehicles for cooling and heating electronic machinery in space.

United Aircraft Forms Research Sudsidiary

United Aircraft Corp., which recently took the full plunge into the missile field (m/r July 7, p. 5), last week announced a further step—formation of United Research Corp. to "sponsor and support" basic research in fields pertinent to the company's interests.

First assignment will be research in advanced propellants for missiles and space craft, in cooperation with Stanford Research Institute.

Lt. Gen. Donald L. Putt, recently Deputy Chief of Staff for Development, Headquarters, USAF, has been named as president of the new corporation. Other top men in the new firm include Dr. Isidor Rabi of Columbia University; Dr. C. Richard Soderberg, dean of engineering at MIT; Dr. H. Guyford Stever, assistant dean of engineering at MIT; Dr. Bernard Lewis, of Pittsburgh, and S. Allan Kline, president of Sierra Metals Corp.

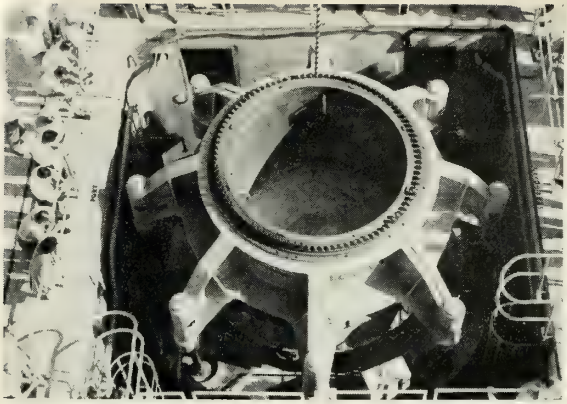
Rocket Mail Flight to Mark End of IGY

The largest demonstration of rocket post yet conducted will take place December 31 when six letter-carrying rockets flash across the Nevada-California border to commemorate the end of the International Geophysical Year.

Six thousand special rocket envelopes from stamp collectors will be aboard the sleek, fourteen-foot long by three-inch diameter rockets which will be launched by the Rocket Research Institute from Clark County, Nev., to Nipton, a small mining town in San Bernardino County, California, two miles away.

B-52G to be tested

The B-52G strategic bomber designed to carry two GAM-77 *Hound Dog* missiles will undergo flight tests at Edwards AFB starting this month. The new version of the long range bomber has increased range of 25%, speed in excess of 650 mph., and reduced weight. In addition to the two missiles, the plane will carry nuclear weapons in its bomb bay.



SIMULATOR CAN DROP 14 feet as it rolls and pitches.

Polaris SMS Equipment Undergoes Cape Tests

by William O. Miller

Cape Canaveral—The Navy has spent upwards of $3 million to make sure that when *Polaris* is put into a submarine, it will be thoroughly acclimated to the roll, pitch and heave of its underwater environment.

A movement simulator, now undergoing final acceptance tests at Cape Canaveral, was put through its paces for the first time a few days before a full scale, two-stage *Polaris* test vehicle failed in a second firing from the Florida test center.

The SMS (Ships Motion Simulator), popularly known as the "Shaker," was designed, built and installed by the Loewy-Hydropress Division of Baldwin-Lima-Hamilton Corp. It will allow the Navy to study actual conditions under which the *Polaris* will have to be stored and fired. It also will pre-test the missile.

The "Shaker" will enable engineers to study the influence of ship movements on the structure, the guidance system, safety elements and overall characteristics of the fleet ballistic missile; and equally important, in developing handling and servicing techniques.

There are six directions in which a ship moves. However, only three have any appreciable effect on launch characteristics and missile structure requirements. These are roll, pitch and heave.

The "Shaker" can accurately simulate all of these motions by means of two large diameter and concentric cylindrical rings which are gimbal-mounted to permit angular motion of the longitudinal axis of the inner cylinder in roll and pitch or in any vertical plane. These gimbals are mounted on a crosshead assembly which is connected to a series of guides located on the walls of the pit, which will move in a vertical direction only. This vertical movement is equivalent to the heave motion.

The entire assembly is supported by four hydraulic cylinders. Two of these are working cylinders controlled by hydraulic valving, while two are uncontrolled and considered counterbalances to part of the platform weight as it is lowered, thus saving power.

Roll and pitch motion is provided by four additional cylinders arranged in opposing pairs. The planes are at right angles to each other. The cylinders are ball-ended at both ends to permit oscillatory motion of the platform.

- **Simulator use**—It is planned to record on board a submarine the actual ship movement, which then can be brought back and programmed into the simulator. While the *Polaris* is primarily designed for underwater firing, where movement is a fraction of surface movement, the surface firing of the missile is not ruled out.

First use of the simulator will be in a series of pop-up test shots of the ejection system that launches the *Polaris* by hydraulic pressure. Once on the surface, the first stage solid-propellant engine will be fired.

A forced vibration system is used in which fluid pressure is applied alternately to opposing cylinders in each pair, and roll and pitch oscillations are set up and maintained as long as hydraulic fluid is provided. The upward heave is by fluid pressure to the vertical actuating cylinders, with downward movement gravitational.

When demonstrated, the simulator went through a plus and minus eight-degree pitch motion, a plus and minus eight-degree roll motion, and a plus and minus seven-foot heave motion. The combined roll and pitch was within an eight-degree cone. Time per cycle is 6-14 seconds.

The upper and lower surfaces of the inner gimbal ring are equipped with flanges and bolting to accommodate the *Polaris* launcher (DPL-2) made by Westinghouse, launch contractor. Lockheed Missile Systems Division operates Complex 25 for the Navy and conducts the flight test program under Navy supervision.

- **Subsurface installation**—The subsurface installation of the 400,000 lb. launcher and simulator posed special construction problems due to the necessity of digging a 55-foot pit into sandy Florida soil, totaling 23,000 cubic yards. Proximity of the ocean and the Banana River necessitated a dewatered sheet pile cofferdam. Original water table is eight feet below grade. The 47-foot deep by 33 foot square rests on a seven-foot thick plug within four-feet thick sidewalls. Construction required pouring of 3,800 cubic yards of concrete.

The simulator, as part of the Fleet Ballistic Missile program, has a DX priority, the highest that can be awarded. The entire program is under the supervision of the Navy's Bureau of Ordnance Special Projects Office, Rear Admiral William F. Raborn, director.

A series of tests of the ejection system in the launching tube has been carried out on the West coast. The dry-land tests were called Operation Peashooter. The submerged tests Pop-up. This was the second test firing from a dry land base. The first test firing of the *Polaris* at sea will be from specially equipped surface vessels. Then the missile and the submarine will be put together for the first complete Fleet Ballistic Missile system.

Five FBM submarines have been ordered. Congress has made money available to the Department of Defense for two additional boats, but Secretary McElroy has declined to give the green light. It was explained at the time of the decision to hold back money for the two boats, that seven boats were all that could be considered desirable until the entire system had reached a higher state of development.

Availability of both the submarine and the *Polaris* missile has been set for 1960. Latest reports (prior to this second unsuccessful firing) were that development of both the submarine and the missile were progressing abreast each other.

- **Bridges the gap**—*Polaris* is the first IRBM designed to be launched from a moving platform. To bridge the gap between the earlier stable dry-land launches and the specially-equipped surface ship is the purpose of the ships motion simulator.

For the East coast tests of the *Polaris,* the Navy has taken over a corner of Cape Canaveral to develop the special complex of some 36 acres. There are some 5,000 square feet in buildings in the pad area. Hangar Y nearby, has an additional 60,000 square feet. It is in Hangar Y, the main building, that *Polaris* test missiles are assembled.

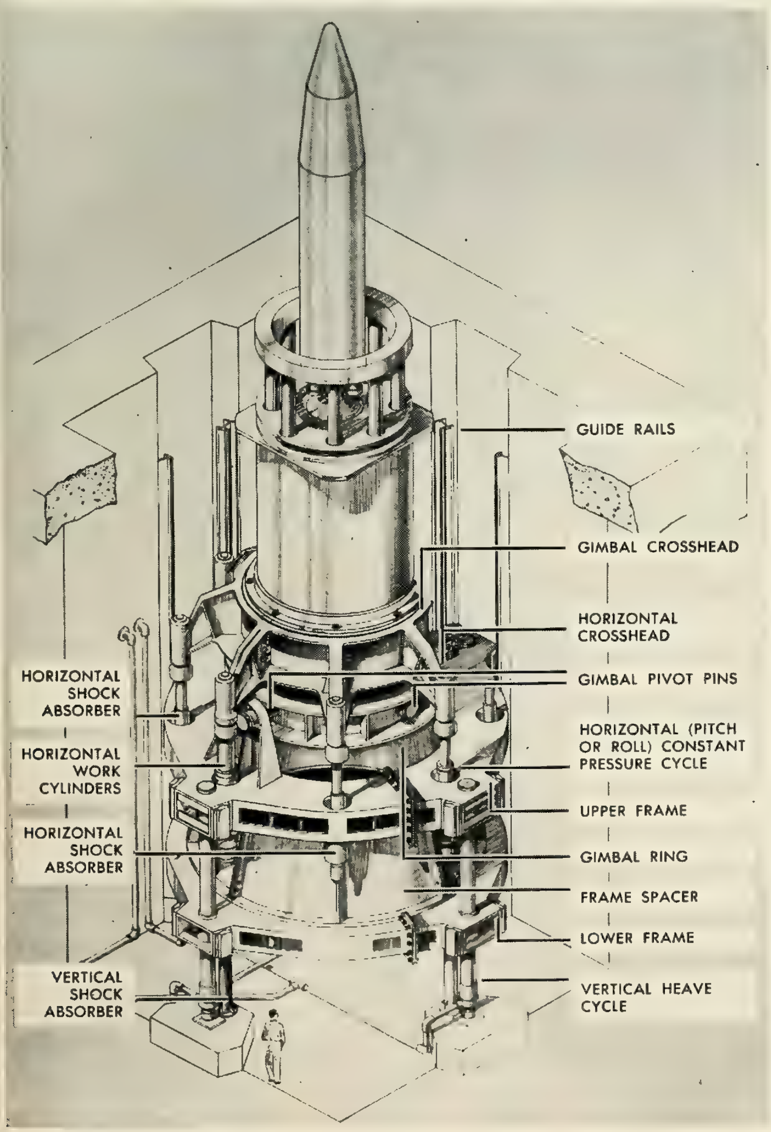
The systems are checked and final adjustments made for the launching. Other facilities making up the *Polaris* complex include several laboratories, receiving and recording equipment and an engineering laboratory.

- **Power specifications**—Just to the east of the SMS and also underground are the power units which enable the simulator to go through its gyrations which are somewhat reminiscent of an elephant doing a cake walk.

The major source of power is a 2,250 horsepower pump and a second pump with the capacity for another 700 horsepower. Control of the three desired motions to be simulated is done through specially designed, servo-positioned hydraulic throttle valves. This permits very close control independently of each of the three motions.

The electronic control system facilitates quickly setting up the separate or combination of motions desired. The introduction of actual ship movements recorded at sea is done by means of three channel magnetic tape.

Total maximum power of the simulator is 3,000 horsepower. Hydraulic drive pumping capacity is 2,000 GPM. The working pressure of the hydraulic system is 3,000 PSI.



SHIP MOTION SIMULATOR without the launcher and artist's conception of *Polaris*.

Third *Polaris* Firing Probable Within Month

CAPE CANAVERAL—Despite the highly successful tests of individual components, the Navy's top-priority *Polaris* seems to be running the normal course in the first phases—tests, failures of various systems, and disappointing but knowledge-yielding firings.

The major cause of failure in last week's firing apparently was in the solid-propellant first stage. After some seconds, the second nipple-like stage ignited and, separating itself from the booster, climbed in an arc for seven seconds to explode on impact about one and one-half miles away.

The first stage, continuing its faulty programmed sequence, never left the pad and continued to chug and puff 20-foot columns of flame at half second intervals—a familiar symptom of combustion instability.

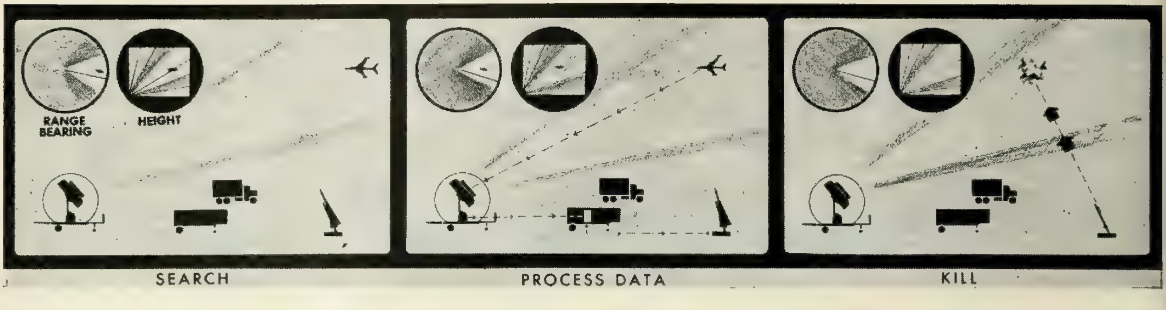
The Navy offered no explanation as to what caused this second failure. One spokesman did say: "It was a disappointment but we can take solace in the fact that we are discovering weaknesses through these failures in the early phase."

The first test shot several weeks ago was destroyed by the range safety officer when it failed to tilt over into the planned angle. Until that time, the vehicle performed beautifully, according to Rear Admiral William F. Raborn, head of the Navy's Special Projects Office.

The Navy declined to estimate when the third in the series of shots would be carried out, but one estimate is it will be about a month before another firing could be tried.

The last major change in the *Polaris* components was the changing from earlier Thiokol propulsion units to those manufactured by Aero-jet for the first stage.

Missile Monitor to Use 3-D Radar

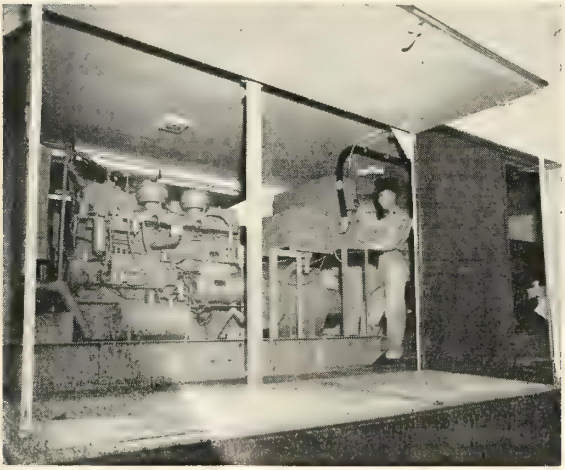


New unit, called Frescanar, to provide eyes for Missile Monitor, Army's tactical air defense system. Radar plots range, speed, direction, and height of multiple air targets simultaneously. Army to order several for testing.

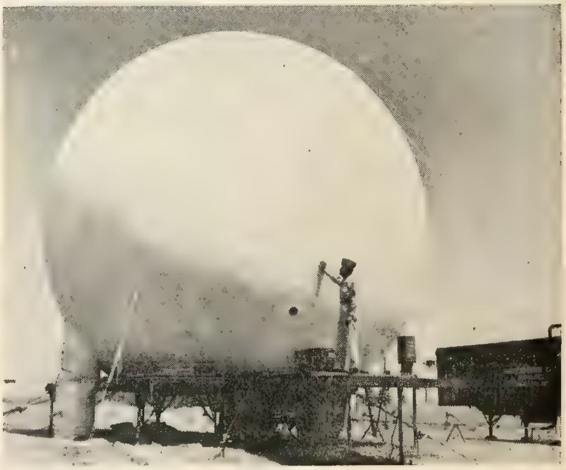
This new army radar—described by Brig. Gen. Earle F. Cook, U.S. Army Signal Corps as the eyes of the Missile Monitor System—is a completely mobile unit which uses a new technique in the detection of multiple air-borne targets by electronic means.

Missile Monitor is a mobile air defense fire distribution system for a field Army's missiles. Gen. Cook describes it as the tactical counterpart to Missile Master, the Army's electronic coordination and control system already operational for the *Nike-Ajax* and *Nike-Hercules* missiles.

The radar, originally developed by Hughes Aircraft for Navy shipboard use, scans a volume of space electronically by moving the antenna beam up and down. The pointing direction of the beam is sensitive to the frequency of the



POWER VAN with side flaps raised. At Army's demonstration, two vans were used—one on standby.



PLASTIC BALLOON houses Frescanar antenna. Bag on left is a pressure hatch for entering balloon.

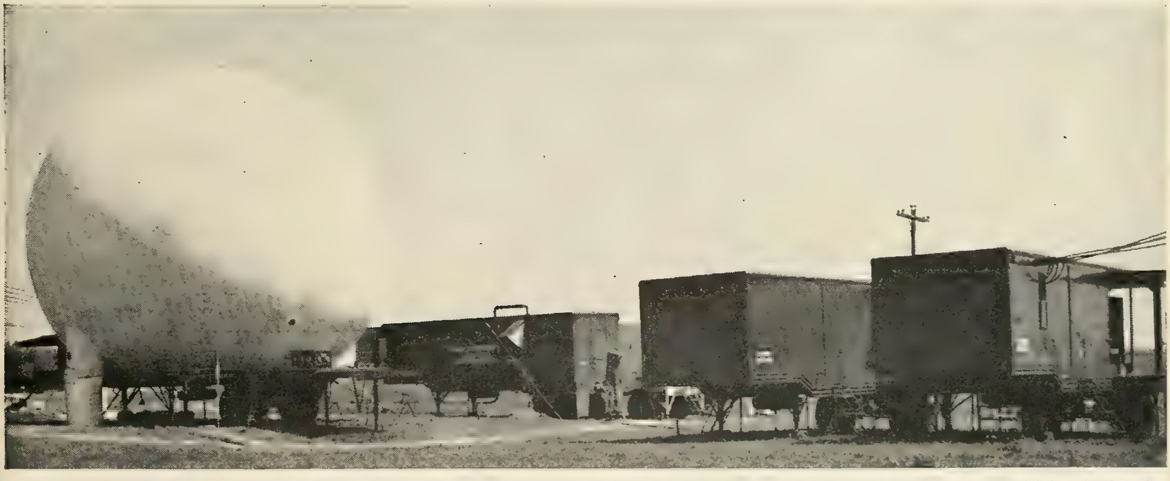
CONSOLE SECTION of the new "3-D" radar slides out for easy maintenance. The unit uses printed circuit cards extensively for quick replacement.

OPERATORS' POSITIONS. Scope on left shows target range and bearing; that on right, altitude. Date is transmitted instaneously to missile batteries.

applied energy to the antenna, so by varying the beam frequency, the new unit can scan up and down at the speed of light with a different scan angle for each applied frequency.

The unit, called the AN/MPS-23 frequency scanning radar and dubbed "Frescanar" by Hughes Aircraft, has been under extensive test and development since 1952, although a Hughes spokesman says that the frequency scanning principle was first investigated about ten years ago.

The inflatable radome is made of rubberized nylon, vulcanized to two layers of neoprene-coated fabric. It weighs about 600 pounds and can be inflated in a matter of minutes after an operating location is selected. The system is similar to Martin's Missile Master.



FRESCANAR SYSTEM set up and ready for operation. At left is the plastic radome housing 15-ton antenna which obtains information and sends it to radar van on its right. Only physical connection between radar van and antenna is waveguide for transmission of the microwave energy. Two units on right are active and standby diesel generator vans.

missile people in the news

New Planning Chief Named by Melpar

Dr. George E. Valley has been appointed Director of Development Planning at Melpar, Inc., Falls Church, Va. Dr. Valley, formerly Air Force Chief Scientist, was instrumental in the development of the SAGE radar early warning system.

Engineering

James H. Reid was appointed chief engineer of the Subsystems Division, Servomechanisms, Inc. Reid was in charge of Electronic Systems Predesign at the Convair Division of General Dynamics Corp., and prior to his association with Convair, he was a project engineer with the A. B. DuMont Laboratories. Reid has had extensive experience in electronic research and development of airborne systems and instrumentation, and in the administration of scientific programs.

Top Brass

John C. Cain of Greer Hydraulics, Inc. has been named treasurer of the corporation. He will continue in his present position as controller of the corporation, a post he has held since November, 1957. Prior to joining Greer, he was manager of Cost Accounting and Estimating for American Bosch Arma Corp., and assistant treasurer of Wallace and Tiernan, Inc., according to a company announcement.

Leonard J. Fletcher, (vice president of Caterpillar Tractor Co., retired) has been elected a director of Holex Inc., Hollister, California, producers of PEP (Packaged-Explosive - Power Units). Fletcher joined Caterpillar in 1927 in a sales capacity, later holding the posts of assistant general sales manager, director of training, and assistant to the chairman and president.

R&D

J. L. Shultz has joined Stavid Engineering as senior scientist. Schultz, an expert in military electronics, was responsible for the design and development of Airborne Early Warning Radar projects at General Electric in Utica. Schultz is a senior member of the Institute of Radio Engineers and a member of professional groups on Engineering Management, Information Theory, Military Electronics, Computers and Communication Systems.

Industry

Appointment of **E. C. Karnavas** as manager of the Capacitor Department of Texas Instruments Inc., Semiconductor-Components Division, has been announced. Karnavas joined Texas Instruments in 1952 as one of the first employees in the semiconductor products group, and was project engineer on the first grown junction transistors manufactured by TI.

William G. Alexander has been named general manager of Stromberg-Carlson-San Diego, a division of General Dynamics Corp. Alexander has been chief engineer since joining the organization in January, 1957. He will continue in that capacity, in addition to his new responsibilities.

The appointments of **Donald F. Wentzler** as director of planning and organization and **Edward J. Felesina** as director of public relations and advertising at ITT Laboratories, Nutley, N.J. division of the International Telephone and Telegraph Corp., have been announced. Wentzler, formerly manager of professional staff relations at Federal Telecommunication Laboratories joined ITT in 1956.

Lockheed's R&D Growth Creates New Post

Growth brought on by several new classified projects, in addition to the X-7 test vehicles and the Q-5 target missile systems, has caused Lockheed to name a top manager for research & development at the Missile Systems Division, Van Nuys, Calif.

Appointed to the new post is **Thomas P. Higgins,** formerly missiles and spacecraft manager in preliminary design at Lockheed's California division plant, Burbank. Previously the plant's R&D was directed from Lockheed's Palo Alto plant.

Advertising correspondence should be addressed to Advertising Sales Manager, Missiles and Rockets, 17 East 48th Street, New York 17, N.Y.

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advertisers' index

Aerojet-General Corp., Sub.-General Tire & Rubber Co. 10
American Bosch Arma Corp. 8
Avco Mfg. Corp. 35
Bendix Aviation Corp., Bendix Systems Div. 22
Clifton Precision Products Co., Inc. 36
Diversey Engineering Co. 6
Hydro-Aire, Inc. 2
Janitrol Aircraft Div., Surface Combustion Corp. 4
Marman Div., Aeroquip Corp. 3
Resistoflex Corp. 19
Thiokol Chemical Corp. 15
Vickers Inc., Div.-Sperry Rand Corp. 23

How to start an Industrial Revolution. Avco's Lycoming engineers have done it, with a new idea in power. Gas turbine power . . . rugged, lightweight, mobile, and amazingly versatile. Already in production for aircraft, Lycoming turbines are adaptable for boats, heavy trucking, for hundreds of uses. Look to Lycoming turbo power to create new industries, new strength for America.

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MORE THAN 30,000 SHIPPED TO CUSTOMERS OVER THE PAST THREE YEARS

ACTUAL SIZE

SERVO MOTOR
Input Power
(total)
3.8 watts
Stall Torque
.15 oz in min.
.20 oz in nom.
Max. Weight
29 gms.

SERVO MOTOR
Input Power
(total)
5.6 watts
Stall Torque
.3 oz in min.
No Load Speed
6500 rpm min.

MOTOR GENERATOR
Generator:
Input Voltage
10 v
Output Voltage
0.13 v /1000
rpm max.

DC MOTOR
Output Power
4.0 watts
No Load Speed
20,000 rpm
Input Voltage
28 v DC

LINEAR TRANSFORMER
Linearity
.5%
Null E at EZ
.015 v
Phase Shift
15 deg. lead

TRANSMITTER
Accuracy
7′ error max.
Null
30 mv. max.
Phase Shift
8.5 deg. lead

RECEIVER
Accuracy
30′ max.
error spread
Torque Gradient
2200 mg-mm/
deg.
Input Power
.54 watts

CONTROL TRANSFORMER
Accuracy
7′ error max.
Null
30 mv max.
Phase Shift
8.5 deg. lead

DIFFERENTIAL
Accuracy
7′ error max.
Null
30 mv max.
Phase Shift
9 deg. lead

RESOLVER
Accuracy
7′ error max.
Null
30 mv max.
Phase Shift
11 deg. lead

LOOK TO CPPC FOR SYNCHRO PROGRESS

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Clifton Heights, Pennsylvania

NOVEMBER 3, 1958

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missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

Engineering and Electronics Edition

AN AMERICAN AVIATION PUBLICATION

NOV 1958
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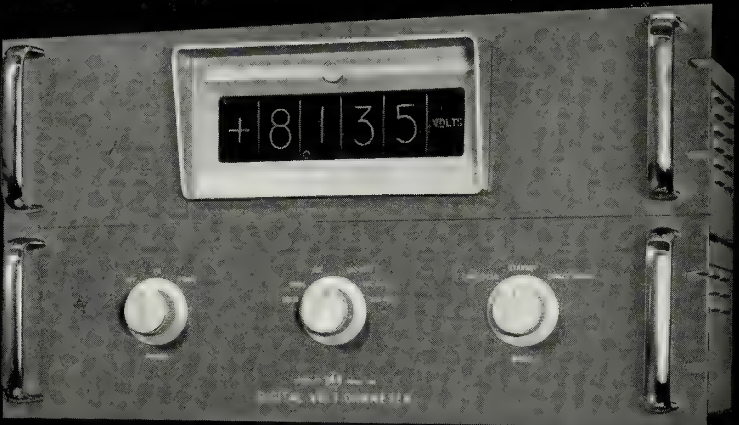
NEW

Transistorized

Digital Voltmeters for Missile Check-out Systems

MODEL 24
4-DIGIT VOLT-OHMETER
Measures DC Volts, Voltage Ratio, and Ohms



The *first* digital voltmeters designed specifically for missile and weapons system check-out . . . the *first* compact, single-unit instruments to automatically and continuously measure and display DC voltages, voltage ratio, and resistance . . . the *first* digital voltmeters to attain the high standards of performance listed to the right! With their many exclusive features, NLS Model 24 instruments provide greater reliability and far more flexibility than have ever been offered before in digital voltmeters. See these new ultra-reliable, high-speed instruments in action! *Wire or phone collect* to arrange for an on-the-spot demonstration of the NLS Model 24 Digital Voltmeters.

ACCURACY

Scale factor and linearity accurate to 0.01%, approaching accuracy of standards laboratory equipment. 10 megohm input impedance.

RELIABILITY

Utilizes transistors and mercury-wetted relays. Provides highest degree of reliability ever attained in any digital voltmeter.

SPEED

Five times faster than conventional digital voltmeters. Displays a minimum of three measurements per second.

CONVENIENCE

Easiest to operate, easiest to read. Only NLS provides all of these features in one compact instrument: automatic range changing, automatic decimal placement, automatic polarity indication . . . exclusive snap-in readout with no-glare hood . . . plug-in component modules throughout.

VERSATILITY

Plug-in connectors allow for simple attachment of such accessories as AC/DC converter, low-level amplifiers, remote readouts, and serial converters to permit driving of automatic typewriters, flexowriters, and tape or card punching units.

INSTRUMENTS TO MEET EVERY APPLICATION

NLS manufactures the most complete line of three, four, five, and six digit instruments for automatically measuring and displaying DC and AC voltages, voltage ratio, and resistance.

Originators of the Digital Voltmeter

non-linear systems, inc.
SAN DIEGO COUNTY AIRPORT,
DEL MAR, CALIFORNIA

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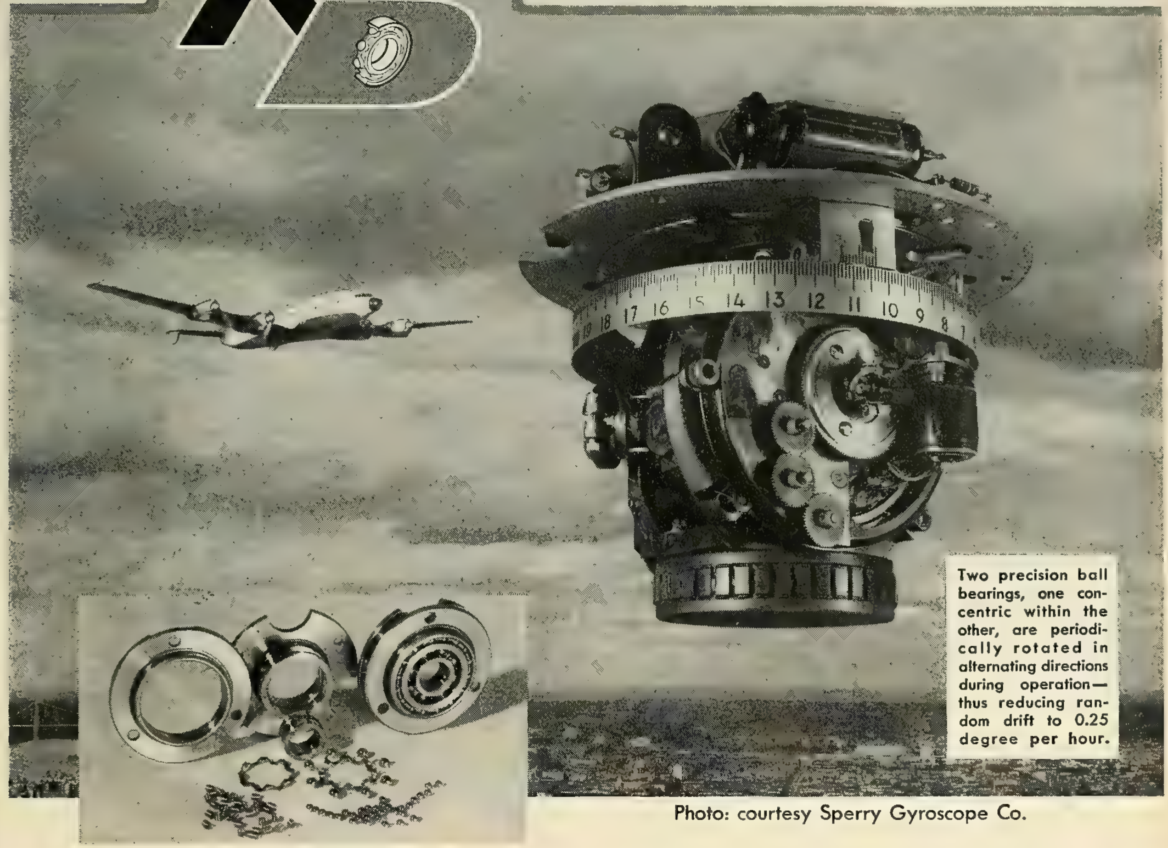
CASE HISTORIES



Two precision ball bearings, one concentric within the other, are periodically rotated in alternating directions during operation—thus reducing random drift to 0.25 degree per hour.

Photo: courtesy Sperry Gyroscope Co.

1,200% Gain In Gyro Accuracy With N/D Ball Bearings

CUSTOMER PROBLEM:

Get new, advanced gyro bearing design "off the board" and into production. Sperry Gyroscope Company, in developing its new Rotorace (TM) gyro, designed a special bearing capable of "averaging out" error-producing effects of friction on sensitive gyro gimbals. New manufacturing techniques would be required to achieve high degree of precision required by Sperry design.

SOLUTION:

N/D Engineering, when approached by Sperry, created special manufacturing techniques for the high precision production of these unique piggy-back gimbal ball bearings. Used in the Rotorace design, the bearings helped achieve reduction of the gyro's random drift rate. The 2 or 3 deg. per hour drift, recently considered very good, is now cut to as little as 0.25 deg. per hour, with still lower rates in sight. Another example of New Departure's ability to meet exacting instrument bearing requirements through broad engineering experience and precision manufacturing techniques.

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NOTHING ROLLS LIKE A BALL

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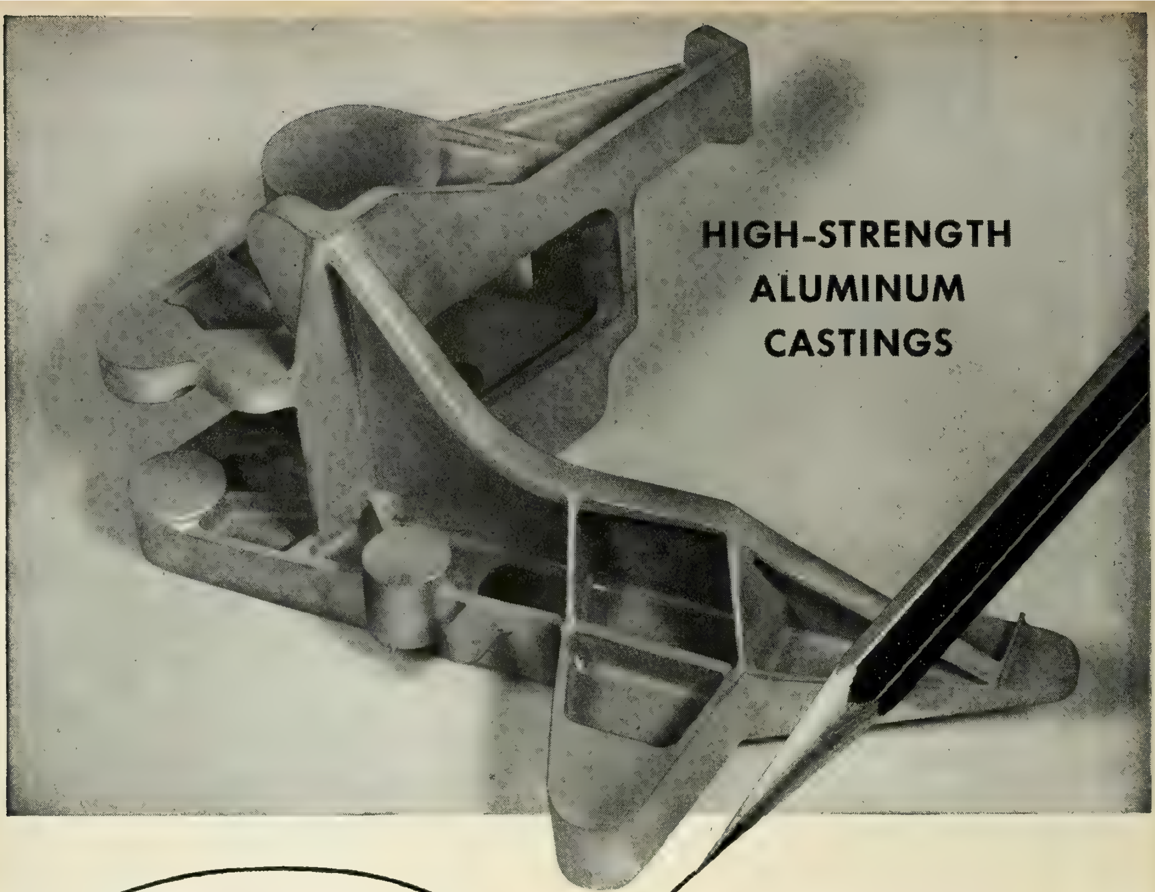

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Brake Shoe produces sand, permanent mold, and plaster mold castings—from a few ounces to 500 pounds—in both high-strength and standard alloys. Government certified heat treat, Zyglo, and X-ray. Send drawings of your problem parts and let our engineers show how critical, hard-to-make designs can be produced as high-strength aluminum castings. Delivery from our plant at Mahwah, New Jersey, or our Gaines Works at Rivera, Calif.

**Guaranteed Properties in highly stressed areas.*

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Other grades available to all military specifications.

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COVER: *The planet Mars is ready and waiting for scientific exploration. First exploration will be by ONR's Strato-Lab IV balloon (page 14), but the "red" planet will be in favorable position for a rocket probe in November, 1960, which probably will be undertaken by NASA.*

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in this issue

NOV. 3 HEADLINES

Krushchev-Mao Bargain Included Missiles
Talks between two leaders, according to intelligence reports, resulted in Red China getting missiles for use against Formosa 11

***Pioneer III* Readied for November 7**
Air Force is taking steps to insure full burning time for second stage 11

***Explorer VI* Had Problem**
Balloon satellite had to buck heavy odds in achieving critical orbit plan 12

Major Research for Solids
ARPA authorizes services to start negotiations for an integrated solid propellant program 12

ASTRONAUTICS ENGINEERING

ONR Ready for Telescope Study of Mars
Strato-Lab IV Balloon scheduled for launch from South Dakota 14

LOX Ground Handling Still Problem
Principal oxidizer continues to provide troubles that can be solved only by new methods and equipment 21

MISSILE ELECTRONICS

Auxiliary Power Systems Challenge Chemicals
Expanding "Power for Space" business is discussed in special report by Editors Peer Fossen and Alfred J. Zaehringer 30

DEPARTMENTS

Washington Countdown ... 7
Industry Countdown 9
Space Age 48
Astrionics 55
New Missile Products 57
Contract Awards 62
When and Where 65
Editorial 70

Sixth sense for Republic's F-105

Advanced versions of Republic's F-105 will be able to nail targets on the head, night or day, cloudy or clear—even if the targets are hidden deep in rugged mountains. This remarkable capability stems from NASARR—the F-105's monopulse radar system—developed and manufactured by Autonetics for the AN/ASG-19 armament control system.

Lightweight, compact NASARR is the only system in production that provides these radar functions for both low-level and high-level missions...air search, automatic tracking, ground mapping, and terrain avoidance.

Like Autonetics' other advanced guidance and control systems, NASARR is reliable *and* available. Years of R & D... of working ahead of the field...have made it so.

Please write for more detailed information.

Autonetics

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washington countdown

Battlefield mobility . . .
concept of Army has industry buzzing with proposals with prospects that the service will spend a reported $5 billion annually for three years. There are three missile systems—A, B, C. *Mauler,* surface-to-air infra-red against low-flying aircraft, which Martin and Convair reportedly have study contracts for is one. Another system involves Chance Vought, Douglas, Minneapolis-Honeywell, General Electric, Armour Research, and Cornell. C-V calls its small diameter, swiveled rocket, *Project Firepower,* and may test fire it in January. C-V reportedly has invested $6 million of own money in developing 70-mile range missile. Other system may involve missile called *Little Jim.*

First independent . . .
action of NASA may be an equatorial test range—long advocated for satellite launchings. U.S.-owned Howland, Christmas and Baker Islands in South Pacific may be good guesses.

New Red China sell . . .
is the lethal *Sidewinder,* displayed for propaganda to 50,000 persons recently in Peiping. Missile took precedence over a display alleging U.S. "germ warfare" in Korean war.

Space leadership . . .
can be obtained by U.S. only if there is high priority in erecting a manned laboratory in space, according to Dr. Arthur Kantrowitz, director of Avco Research Lab. He said last week the U.S. could do it at a cost of $1,000 a pound with the lightest capsule proposal weighing about 1,400 pounds.

USSR ballistic missile . . .
production is about 2,000 per month, with intelligence sources estimating goal of 20,000. About 30% will be IRBM's with remainder being medium and short range.

Soviet rocket bases . . .
in Czechoslovakia are at Joachimsthal, Karlsbad, southwest of Reichenberg, northeast of Olmutz, near Bohmen-Budweis, and Javorina. Hungarian bases are near Tapolca, Papa, and Hajmasker. East German bases are Kolberg, Libau, Memel, and Reval.

Rickover's promotion . . .
to vice-admiral is getting a luke-warm reception in large segments of top Navy brass. Personal feelings and jealousy have little to do with it. Reason: by creating billet, another vice-admiral slot will have to go. Number is specifically limited by law.

House space committee . . .
plans to look into future propulsion system and fuels; will review national space program, accomplishments of IGY, and probably will lay ground rules for international space cooperation.

Soviet espionage . . .
has been unusually successful in British missile program. Secret performance figures on *Black Knight* have fallen into Red hands.

American missiles . . .
will not be manufactured in Britain, says Assistant Defense Secretary Quarles. However, Britain will manufacture U.S. rocket engines under license.

Competitive bidding . . .
has a basic flaw, according to one top defense official, and it's statistically interesting. A number of bids on a statistical scale will show a grouping around the middle with a few scattered on top and bottom. Statistically, middle bidders know more about the subject than the other two, but the bottom one usually gets the contract. Officials complain that the bottom man will usually come back for more money, bringing total cost back up to what the middle bidders thought it should be.

Look for appointment . . .
of Dr. Joseph V. Charyk, director of missile technology of Aeronutronic Systems, Inc., to replace Dr. George E. Valley, Jr., as Air Force chief scientists.

NASA-ABMA compromise . . .
was in the works as m/r went to press. And the compromise reportedly was acceptable to both. One proposal reportedly was that JPL would be transferred to NASA while the Huntsville scientific team would remain with the Army, but would do work for NASA on a project basis (same as it now does for ARPA). Subject probably held a high place on Wednesday agenda of President's Space Council.

Newest

HONEYWELL MINIATURE RATE GYROS

Rugged enough to withstand 100 G shock

Typical M Series Gyro undergoes 20 G Linear Vibration Test with no deterioration of performance.

Sensitive enough to detect 0.005° per second

Model M-1
shown actual size

Honeywell's newest miniature rate gyros, Type M Series, are rugged enough to withstand repeated shocks and linear accelerations up to 100 G yet sensitive enough to detect turn rates of only 0.005 degrees per second. A damping ratio variation of 2 to 1 or better is maintained without heaters by a unique fluid damped, temperature compensated system that assures reliable operation over the entire operating temperature range.

Type M Series Gyros are specifically designed for autopilot damping, radar antenna stabilization and fire control applications. Their small size, high performance and ruggedness suit them particularly for high performance military aircraft and guided missile applications. Write for Bulletin M to Minneapolis-Honeywell, Boston Division, Dept. **45**, 40 Life Street, Boston 35, Mass.

DESCRIPTIVE DATA

FULL SCALE RANGE: to 400 degrees per second

THRESHOLD-RESOLUTION: 0.005 degrees per second

LINEARITY: 0.1 % to 2 % depending on range

DAMPING: 2 to 1 (or better)

TEMPERATURE RANGE: −65 to +200 and +250°F

SHOCK AND ACCELERATION: 100 G

VIBRATION: 20 G to 2,000 cps

PICKOFF: Variable Reluctance type providing infinite resolution and high signal-to-noise ratio

MOTOR EXCITATION: 26 volts, 400 cps (standard)
2 phase and 3 phase

SIZE: 1" diameter, 2¾" long

WEIGHT: 4.5 ounces

Honeywell

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industry countdown

First tests for nuclear rocket . . . reactor will be started with in the next few weeks. The reactor, dubbed *Kiwi-a,* is the result of three years of secret, low-level research and development activity in the Air Force-Atomic Energy Commission Project *Rover* program. The AEC is charged with reactor development and the Air Force with non-nuclear components.

Rocketdyne and Aerojet-General . . . are working on the reactor and nuclear fuel materials furnishing valves, pumps, and other system components. ACF Industries has built the reactor vessel for *Kiwi-a* with instrumentation for the tests the responsibility of Edgerton, Germeshausen & Grier, Inc. Some 12 other firms have subcontracts.

Large Tracts of land . . . have been picked up by Rocketdyne in the Nevada area for anticipated facilities expansion connected with Project *Rover.* With some $25 million spent on *Rover* to date and approximately $35 million anticipated for the next fiscal year, a steadily increasing budget is looked for on *Rover* and *Pluto* (nuclear ramjet). Air Force predicts that billions will be spent on the projects before a successful rocket or missile is a reality.

***Bumblebee* program . . .** has received a much needed boost with the Navy award of $17 million for continued research and development on surface-to-air missiles at the Johns Hopkins Applied Physics Laboratory. *Bumblebee* is a pioneer project with such accomplishments as *Terrier, Tartar,* and *Talos.*

New propellant battle . . . has developed, this time storable package liquids versus storable package liquids. Package liquids proponents say the battle in the near future will overshadow the present solid vs. liquid hassle and solid long range missiles such as *Minuteman* and *Polaris* will fight for existence. All that's needed by the package people is the same old bugaboo—money for development. Top competitors at the moment are Aerojet and Thiokol-Reaction with Reaction making the strongest bid. Production heads say it is only a matter of scale-up to any size unit needed. To date scale-up has been meager (*Sparrow* and *Bullpup*) but ample enough to confirm feasibility.

Communication with space-vehicles . . . or other planets may soon require the serious attention of the Federal Communication Commission. Press Wireless has requested confirmation of FCC's understanding that its present license would permit communication with outer space. Press Wireless stated it wants to provide an informational communications service with manned satellites, space platforms, or space expeditions.

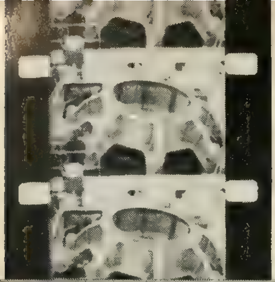
Major *Minuteman* subcontractors . . . to assist Boeing in the assembly and testing research and development program are: American Telephone & Telegraph Co., for communications; Bechtel Corp., for sites; and Four Wheel Drive Truck Co., for ground handling equipment.

***Bomarc* weapon support equipment . . .** at Eglin AFB, Fla., first installation of the Air Force surface-to-air weapon system, is receiving finishing touches. Palu Hardeman, Inc., is responsible for installation, calibration, and check-out of the equipment for the first four or seven launching shelters. *Bomarc* will be test fired from Eglin. Construction on the *Bomarc* base at Riverhead, Long Island has progressed and contractors have been given approval to open the base to public view on November 20.

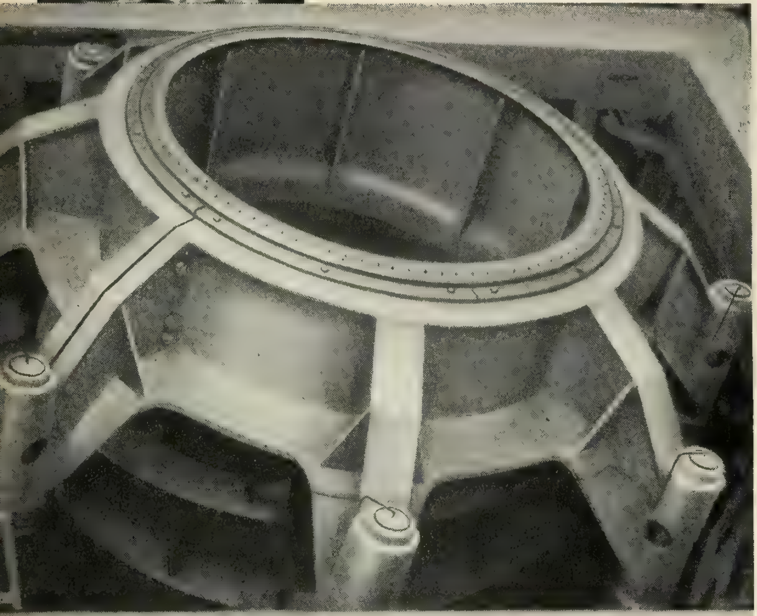
Army has spent $564 million . . . for construction of air defense sites in the continental U.S. in the six-year period from fiscal years 1953 through 1959. The same amount reportedly will be spent in fiscal year 1960 for *Nike Hercules* and *Hawk.*

AFMTC expects to spend . . . an all-time high of about $306 million during fiscal year 1959. This includes payrolls, new construction, maintenance, and supplies and services incurred by the Center and missile contractors at Patrick AFB, the Cape Canaveral Missile Test annex, and downrange activities.

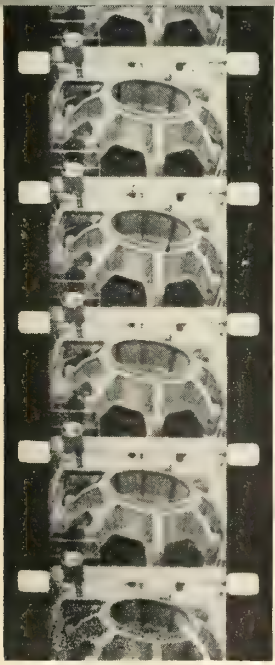
We are accustomed to look upon rocketry . . . as a relatively unpracticed art. However, an Air Force researcher discovered that more than 72,000 ground-to-air rockets have been fired in this country in the last 15 years.



"Shaker" pitching



"Shaker" rolling



"Shaker"—Loewy's giant rocking horse—paves way for ballistic missile firing at sea

The giant ship motion simulator called "Shaker" has come to life. Designed and built by Loewy-Hydropress under prime contract with the U.S. Navy for its Fleet Ballistic Missile Program, the 40-ft.-tall rocking horse moves up and down, fore, aft and athwart under the electronic fingertips of a distant operator in a thick-walled concrete blockhouse.

"Berthed" at Cape Canaveral not more than 800 feet from the beach and nested in a 47-ft.-deep pit, "Shaker" performs all the important movements of a seagoing vessel. Sliding up and down, she imitates the vertical heave motion. Tilting port and starboard, she acts out rolling. Rocking forward and backward, she duplicates pitching. An intricate mechanism of giant gyrating joints makes these rock 'n' roll moves and their innumerable combinations possible. By proper setting, the typical behavior of an oceangoing vessel in seas ranging from calm to stormy can be recreated precisely by "Shaker."

Polaris, the Navy's Fleet Ballistic Missile, will soon be tested on "Shaker."

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NOVEMBER 3, 1958
VOL. 4, NO. 18

missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

Krushchev-Mao Bargain Known

Intelligence Reports Show That Talks Between Leaders Resulted in Missiles for Red China Use

by Alfred J. Zaehringer

WASHINGTON—Through recent intelligence reports from the Far East, m/r has learned that the same Krushchev-Mao bargain which brought about the bombardment of the off-shore islands also gave Red China the capability of being able to bombard not only these islands but Formosa as well with short and medium range ballistic missiles.

Just before the present off-shore islands crisis, Nikita Krushchev visited Red China's Mao Tse-tung. Some high-level missile, satellite and nuclear weapons decisions were made. It is believed that Krushchev sought permission to make ICBM and IRBM tests over China territory. In exchange, the Soviets were to make available to the ChiComms:

1. Short range ballistic missiles. The T-5, T-5B, and T-5C, plus the T-7A solid artillery missiles (ranges of 25-100 miles) have been operational with the Soviets for several years. Old stocks, plus new models, would make it advantageous to use these missiles in the China conflict. Immediate uses: bombardment of the Quemoy and Matsu Islands which are in the hands of Chang. Thus, the Reds could place missile batteries well inland.

2. Medium range ballistic missiles. The Soviet T-1 (range of about 500 miles) has become obsolete with the advent of the T-2 IRBM and the T-3 ICBM. Placing the T-1 in Mao's hands would:

(a) allow the direct bombardment of Formosa, and

(b) allow the establishment of a Red China satellite.

Mao has said that Communist China will establish a satellite. A satellite of *Vanguard* or *Explorer* equivalent could be established with the T-1 plus other stages of the T-series of short range artillery rockets. Which will come first is hard to say. By establishing a satellite, Red China will immediately display to the world the capability of hitting Formosa.

3. Nuclear technology. Though it is probable that Russia has not given Red China nuclear weapons, it is clear that Soviets are rendering technical assistance in setting up research reactors. At the present time, all technical help and supplies are accompanied by Russian technicians. In the near future, however, nuclear weapons will have to be furnished to the ChiComms. Initially, such weapons will be under the control of the Soviets.

Krushchev may also have made a deal to set up Soviet missile bases in China.

Red China's Theory

By using rockets, the ChiComms can bombard the off-shore islands from bases well out of range of Chiang's artillery on Matsu and Quemoy. The U.S. is reluctant, or has been, to give the Chinese Nationalists missiles to fire back.

The only missile available is the *Matador,* now stationed on Formosa in limited numbers. The *Matador* is a subsonic air-breathing missile and greatly effective only when equipped with an atomic warhead. Army says it has no ground to ground missiles there.

The U.S. Air Force or Navy will not attack the ChiComms shore batteries unless Formosa itself is attacked. But the pressure will eventually force the U.S. to give up the off-shore islands as gracefully as possible, giving into ballistic blackmail.

The situation of Formosa, already under the bomb sights of hundreds of ChiComms jet bombers based on the mainland within easy range, will be even more critical. The Formosa defense set up is oriented to protect Formosa from conventional attacks. *Sidewinder* equipped aircraft, *Nike-Hercules* and conventional antiaircraft batteries are useless against ballistic missiles. Thus the same ballistic blackmail will eventually force a bargained solution to Formosa, the ChiComms believe.

Thule in Range

The Air Force's Thule SAC base is under range of Soviet ballistic missiles. The Reds have set up ballistic missile bases on Franz Josef Land.

During the IGY tests this year, some 25 launchings have taken place from this base. IRBM's and ICBM's reportedly equipped with nuclear warheads, have been launched from the base and were included in the current Soviet Arctic atomic tests. The U.S. made high altitude tests reportedly with a *Redstone* in the South Pacific this summer.

About Pioneer

Air Force Changing Guidance Cutoff

In the third Air Force try with the lunar probe, the guidance system on the second stage will be changed from accelerometer cutoff to doppler cutoff, m/r has learned. The firing will be in the early morning hours of Nov. 7 from Cape Canaveral.

In the second attempt last month the accelerometer was set to cutoff at a certain initial velocity based on a precalculated flight path. Due to an over-performance of the first stage, the missile lofted in flight. Thus when the second stage cut off as programmed, the initial velocity was not the true velocity due to the error in the flight angle.

With some 4 or 5 seconds of burning left in this second stage, the maximum velocity reached by the missile was only 34,750 feet per second at burnout.

Due to the error angle the missile reached out only some 68,000 nautical miles. At the correct angle, 35,200 feet per second speed at burnout is necessary to carry it to the exact 162,897 apogee for orbit.

The following table shows how great a variation in velocity and height at apogee only a slight differential in burnout velocity produces:

Burnout Velocity	Apogee Velocity	Earth Radius, Apogee Height
33,000 ft/sec	5010 ft/sec	22,862
34,000	3045	58,611
34,500	2070	79,344
34,750	1600	95,946
35,000	1120	108,466
35,200	750	162,897
35,250	640	191,166
35,300	540	222,760
35.500	170	689,252
35,570	000	infinity

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. . . Pioneer

First stage of the lunar probe is a *Thor* with about 160,000 pounds of thrust. Second stage is a second stage *Vanguard* with about 20,000 pounds of thrust. The third stage, a solid propellant rocket has approximately 8,000 pounds thrust, plus eight small verniers which can be fired for either added boost or correction of flight path. Fourth stage has one "retro" rocket. As this fourth stage cuts loose from the third, it will be travelling at right angles to its longitudinal axis. The "retro" thrust is not designed to slow down the rocket but to give it a thrust parallel to the moon's surface and at right angles to the direction of payload travel.

This fourth stage or payload will again contain radiation measurement equipment, and possibly different scanning equipment, it has been learned.

Scientists on the project estimate that if the final stage approaches within 50,000 miles of the moon it can be placed in orbit. This means, however, as a glance at the table shows, that the burnout velocity still must be controlled between 35,200 and 35,250 feet per second.

If there is to be an error in burning time of the second stage on next firing, an AF spokesman said, it will tend to be on the liberal side. He explained:

"It is a little like rolling a ball uphill and balancing it exactly on the crest. Last time it didn't quite get there and rolled back. This time we are going to give the ball enough 'oomph' to get it to the crest. It can roll over and still go into orbit on the other side—if it doesn't roll too far." Even should that happen AF and NASA, which controls the project, feel that it may scan some part of the dark side of the moon as it goes by.

And, there are many other things to be learned. Astronomers have theorized, for instance, that beyond the moon lies a belt of micro-meteorites. Data from a far-flying *Pioneer III* could measure the width and density of such a belt, or probe whatever else might be there.

Critical Orbit Plan for *Explorer*

by Norman L. Baker

The National Aeronautics and Space Administration's latest scientific satellite attempt, *Explorer VI*, although a noteworthy endeavor, was bucking heavy odds attempting to achieve an extremely critical orbit plan.

Even had the *Jupiter-C* rocket vehicle performed perfectly, the need for an almost unheard of satellite attitude stability at the apogee of its orbit, reduced the chances of success considerably. For this reason many scientists feel that an attainment of a near circular orbit would have been as great an achievement as the successful orbit of the *Beacon* inflatable satellite.

Explorer VI's orbit path was calculated to give the payload an apogee of 400 miles, where, at the slowest position of the orbit, the fifth-stage rocket in the nose of the payload section would have boosted the velocity enough to hold the satellite at that altitude.

This final stage rocket, traveling nozzle forward at the perigee (burnout of the fourth stage) would, because of its 750 rpm spin-stabilized condition, be in a position at the apogee to add its thrust to the momentum of the package.

Of course any variation in the longitudinal axis of the satellite package at the time of firing of the fifth stage would have sent the payload into either a more pronounced elliptical orbit or sent it back to earth in less than one earth revolution.

The total mass of satellite material that would have been sent into orbit with the *Explorer IV* shot was the heaviest to date. The weight of the payload case before separation of the fourth stage was 42.77 pounds, or about 10 pounds more than earlier *Explorer* satellites. This is probably the major reason for the reduced apogee altitude. The empty fourth stage rocket would have separated from the payload case at burnout but would have continued to follow the payload until the fifth stage rocket was fired. In the earlier *Explorers* the fourth stage remained attached to the instrument package.

About 60% of the payload case is occupied by the folded *Beacon* satellite and its auxiliary equipment. The deflated balloon is packed into the aft end of the case at the junction of the fourth stage rocket and the case.

At one revolution from the point of launch (location of new apogee) a nitrogen inflation bottle (opened by a timer) would extend an ejection bellows forcing the balloon out of the case. Simultaneously, gas from the bellows would overflow into the balloon inflating it to its 12-foot diameter.

After balloon separation, the gas would escape into space to prevent decompression destruction in case of meteorite impact. The balloon remains inflated after expulsion of the gas due to lack of atmospheric pressure and the induced balloon rigidity from the laminated aluminum foil.

Remainder of payload consists of a 24 milliwatt telemetering transmitter operating on 108.03 megacycles and the small high-fifth stage rocket. Shortly before the final apogee rocket is fired the nose cap is ejected.

With an estimated lifetime of one week, *Beacon* once in orbit, will enable trackers to make precise analysis of the atmosphere layer and confirm density data obtained from preceding satellites.

ARPA Awards Solid Contracts

Washington—The first step towards setting up a solid propellant supply from the nations' rocket engine industry was taken last week with major research contracts going to four chemical companies.

In making the announcement, Roy W. Johnson, Director of the Advanced Research Projects Agency said the characteristics of solids put them out front.

"Their efficiency, speed of operation, safety and ease of handling making solid propellants a forerunning answer to missile propulsion of the future," Johnson said, and "the long range importance of these research contracts to our ballistic missiles program for all ranges and to our AICBM program cannot be overstated."

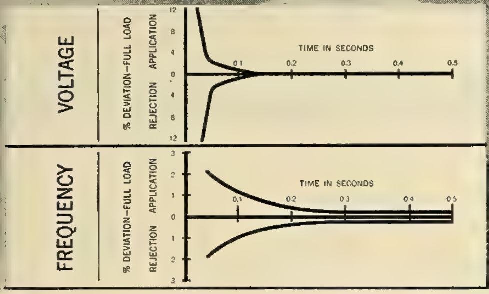
Johnson said solid propellants are becoming increasingly important in the nation's space programs and that the search is for more energetic solids to extend present capabilities.

"The use in upper stage rockets is well recognized," Johnson noted, "however, we have just begun to tap their effectiveness for space applications."

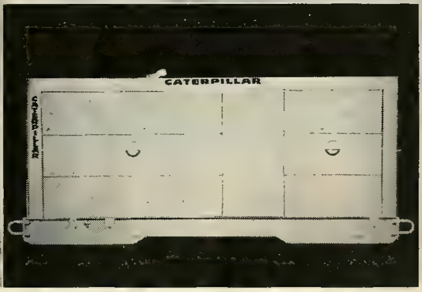
The four companies were chosen from among 30 who participated in the bidding. Eight finalists were selected by the three services. ARPA chose the four companies for negotiation of contracts leading to an integrated solid propellant program. They were: American Cyanamid, Dow Chemical, Esso Research & Engineering, and Minnesota Mining and Manufacture.

The contracts, worth between one and two million dollars each, are unusual because detailed specifications are not given but rather, end objectives. Talent and facilities available were major criteria in making the selection, ARPA said.

The contracts are a result of studies made early in 1958 and a $20 million appropriation to ARPA to step up advanced research in solids in fiscal year 1959.



The almost instantaneous return to normal of the new low-silhouette Cat power unit under conditions of full-load application, and load rejection (117.4 volts), is shown in the above graph.



Low-silhouette Cat power unit with close voltage regulation is now being used in connection with ground support for jet starting and firing. The 400-cycle phase is specifically adapted to missilry.

Caterpillar power fires SNARK... first U. S. intercontinental missile

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The full designation of this specialized power unit is Caterpillar 60 KW 400-cycle 120-208 voltage low-silhouette portable ground support unit with precision voltage regulation.

The secret of this unit is the almost instantaneous recovery to both applied and rejected loads.

Other advantages found in all Caterpillar Engines include: trouble-free operation over a wide range of loads; dependability and long life; economy of operation; maintenance and operation by unskilled personnel; world-wide parts and service, and the ability to operate on any fuel from JP-4 through No. 2 furnace oil.

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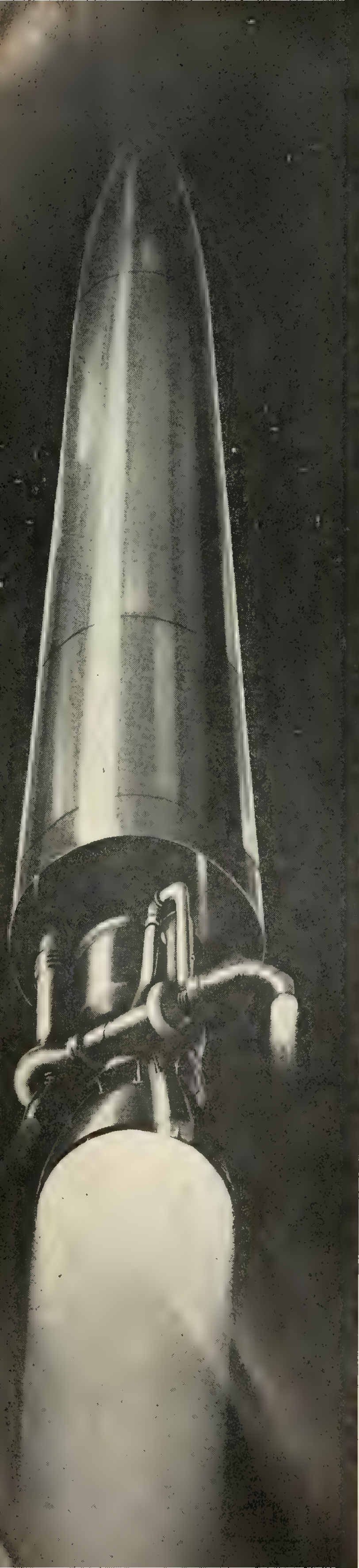


ROCKETDYNE'S single-stage nuclear rocket theoretically capable of carrying large interplanetary payloads.

DR. JOHN STRONG, professor at Johns Hopkins University, will be first scientist to bring instruments to edge of space.

MODEL OF STRATO-LAB IV which Cmdr. M. D. Ross will pilot during ascent to obtain data on Mars' atmosphere.

ONR Readies Stra

by Peer Fossen

As m/r goes to press, members of the Office of Naval Research and The Johns Hopkins University's Laboratory of Astrophysics and Physical Meteorology are jointly engaged in final preparations for the launching of a balloon at the Stratobowl near Rapid City, S.D.

Many balloons have left the Stratobowl before, but this huge plastic sphere will probably be considered one of the most significant in the history of balloon flight, since it will enable man, for the first time, to closer investigate conditions on Mars.

The project—sponsored by ONR and known as **Strato-Lab IV**—calls for Dr. John Strong, director of the Laboratory of Astrophysics and Physical Meteorology at Johns Hopkins, to make an ascent to an altitude of 80,000 feet or more in a pressurized gondola to determine the water vapor content in the Martian atmosphere. This is the first time a scientist has gone to the edge of space with his instruments.

Second member of the two-man gondola team is Cmdr. Malcolm D. Ross, veteran Navy balloonist and ONR physicist, who will serve as pilot.

The feasibility of using balloons for research flights into the stratosphere was demonstrated by Cmdr. Ross this summer when he and Lt. Cmdr. M. Lee Lewis, USN (Ret.) went to 82,000 feet in a record breaking 34-hour balloon ascent.

Project operation—Strato-Lab IV is scheduled to be launched before the middle of the month. The flight will start in mid-afternoon, so the balloon can reach its 15-mile altitude prior to sunset and remain there until mid-morning the following day. The flight, scheduled at a time when Mars will be in the most favorable position for astronomical observations—at a distance of some 45 million miles—is expected to last approximately 24 hours.

Dr. Strong plans to conduct his Mars observations during the night. Soon after sunrise he will focus his attention and instruments on the sun for calibration of its spectrum. The optical system of the observatory will consist of a Schmidt telescope with a 16-inch primary mirror, specially designed by Dr. Strong, for mounting on top of the gondola; a special spectrograph and an automatic star tracker. In addition, manual controls will be provided for orientation and leveling of the gondola.

At the ceiling altitude of about 80,000 feet, the balloon will have left behind it more than 95% of the earth's atmosphere. The little remaining atmosphere between the observatory and

CMDR. ROSS and M. L. Lewis ready to enter Strato-Lab gondola prior to 34-hour record-breaking ascent this summer.

PRINCETON UNIVERSITY astronomers Dr. Martin Schwarzschild (left) and Dr. Lyman Spitzer, Jr. discussing plans for Project Stratoscope. In foreground is model of proposed 36-inch balloon-borne telescope to be flown by unmanned balloon in 1961.

ab IV Balloon for Mars Study

Mars will be insignificant in terms of hindering the scheduled observations. A substantial improvement in the scientific results expected from **Strato-Lab IV** could only be achieved if the observatory were taken outside the stratosphere to an altitude of more than 100,000 feet.

A study for extension of the **Strato-Lab** research program, initiated in 1954, is under way. Under an ONR contract, Vitro Laboratories, Silver Spring, Md., is researching a manned stratosphere laboratory that will be a platform for scientific and technological studies from 100,000 to 120,000 feet above the earth's surface.

Until such a platform becomes a reality, however, observations will have to be limited to the 15-mile altitude level. The team of Strong and Ross has planned a second "Mars-flight" to take place in January next year. The objective of the second flight will be to investigate the oxygen content of Mars.

Future exploration—Balloon astronomy will undoubtedly be replaced to a major degree by satellite-exploration and observations from manned space ships, but prior to that it will have played an important role in paving the way for actual travel in outer space, both through present and future programs.

In a speech before the American Astronautical Society, Cmdr. Ross stated: "Plastic balloon astronomy is not only a stepping stone to satellite and/or true space observatories; it is destined to make its own very positive and important contributions over the next decade or so to a more complete understanding of the universe."

The following studies appear to be the ones made in the near future with Strato-Lab and Stratoscope (see m/r June 1958, p. 73, and October 20, 1958, p. 77): a) observations of the center of the Andromeda galaxy; b) investigations of the gaseous nebula of Orion; c) photography of the aurorae

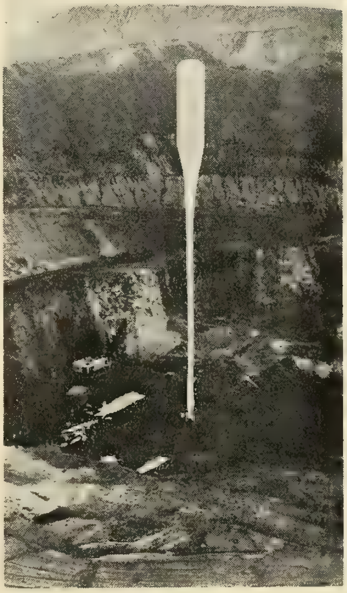
Plastic Balloon Requires No Ballast

WASHINGTON—An Office of Naval Research balloon of improved plastic design, capable of maintaining constant altitude despite temperature differentials, has completed its first test flight from Stanton, Minn.

Conventional balloons are partially inflated at launch, and as altitude is gained and the sun's rays heat and expand the helium, excess gas must be valved off. At sunset when the helium contracts and the balloon loses buoyancy, ballast is dropped to maintain altitude.

The new balloon design eliminates the need for ballast, since the .002 inch plastic skin is strong enough to withstand daytime expansion without bursting. At predetermined altitude, the gas expands sufficiently to completely fill the balloon and cause some superpressure which prevents further expansion and precludes contraction at sunset. Because of the constant cubic displacement, the balloon seeks a constant level.

The G. T. Schjeldahl Co. of Northfield, Minn. developed the balloon for the Navy.



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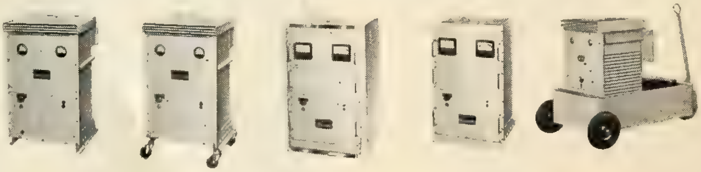

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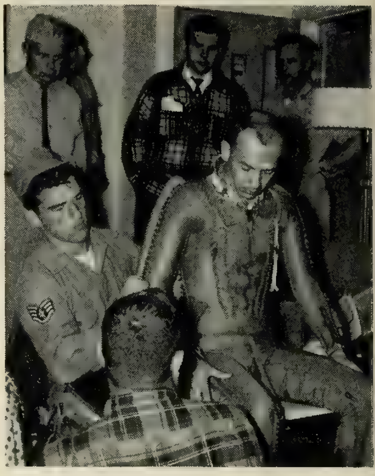


CMDR. MALCOLM D. ROSS being fitted with pressure suit prior to last summer's record-breaking Strato-Lab ascent.

on Venus; d) measurement of the planet diameters; e) photography of Mercury; f) photography of the infrared spectra of all the planets; and g) stellar spectroscopy.

While the balloon astronomers are paving the road for further space exploration, scientists over the world are heavily engaged in research which eventually will lead to satellite and exploratory vehicles for probing Mars, Venus and other bodies. U.S. space scientists have already come up with several proposals for such vehicles, both manned and unmanned.

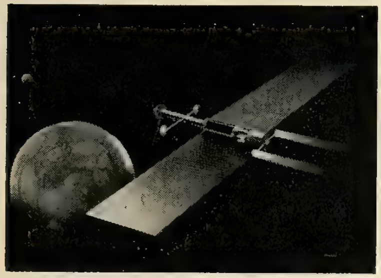
Boeing proposal—One of the more recent proposals for a Mars reconnaissance vehicle came from Boeing Airplane Company. The vehicle, which would measure about 40 feet across and weigh about 600 pounds including payload, could be launched from an earth-bound satellite orbiting 400 miles above Earth. Powered by an ion accelerator, it would escape at low continuous thrust to an Earth-Mars transfer orbit and then descend slowly into an orbit around Mars and scan the planet from an altitude of eight to 9,000 miles.

Payload could include a cosmic-ray counter, meteoroid measuring equipment, radio altimeter, radio-noise-scanner, instruments to explore Mars' atmosphere, and a large tracking telescope. The image picked up by the telescope would be scanned by TV equipment on board the reconnaissance vehicle and transferred to earth by an optical system.

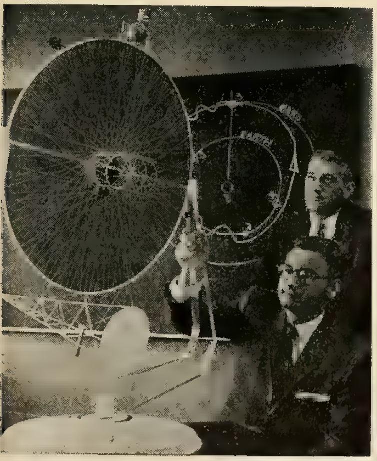
The suggested probe would be constructed of beryllium for all major compression members, piano wire for tension wires, Invar honeycomb core sandwich for the large reflectors, and quartz for the lenses in the navigational system.

The total time elapsed from launching of the vehicle until recovery would be about three years for a reconnaissance trip to Mars. A vehicle of this type could also be used for reconnaissance of other planets.

Neither the National Aeronautics and Space Administration nor the Advanced Research Projects Agency are known to be backing any definite project involving Mars or Venus probes at the present time. However, two months ago, ARPA's Roy Johnson directed the Air Force to make available two additional *Thor-Ables* for scientific use. With Venus in favorable astronomical position relative to Earth in June of next year and Mars coming within "reachable" distance in November, 1960, attempts undoubtedly will be made.



ARTIST'S CONCEPT of Rocketdyne's *Snooper*, an ion-propelled interplanetary vehicle for exploration of Mars.



BOEING'S Richard D. White and Henry K. Hebeler with 1/20 scale model of vehicle for close-up Mars studies.

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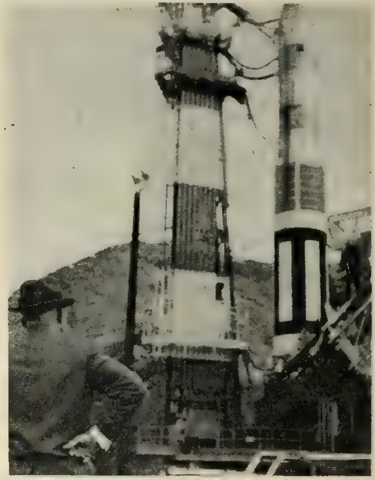

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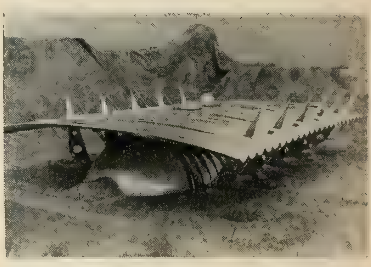

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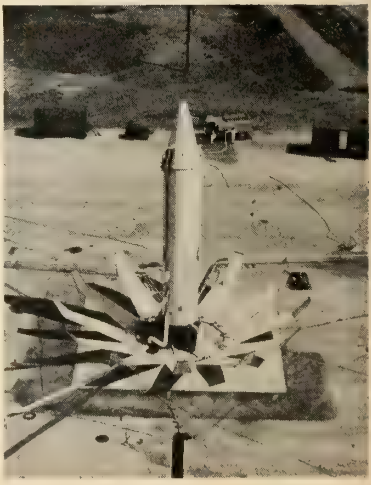

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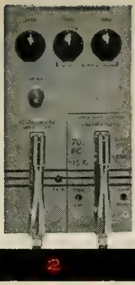
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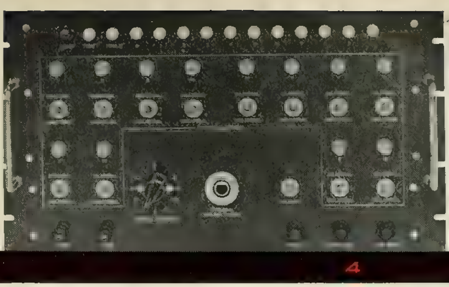
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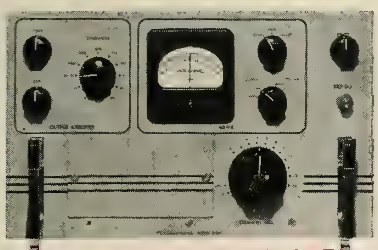
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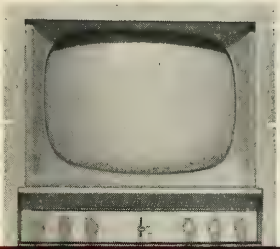
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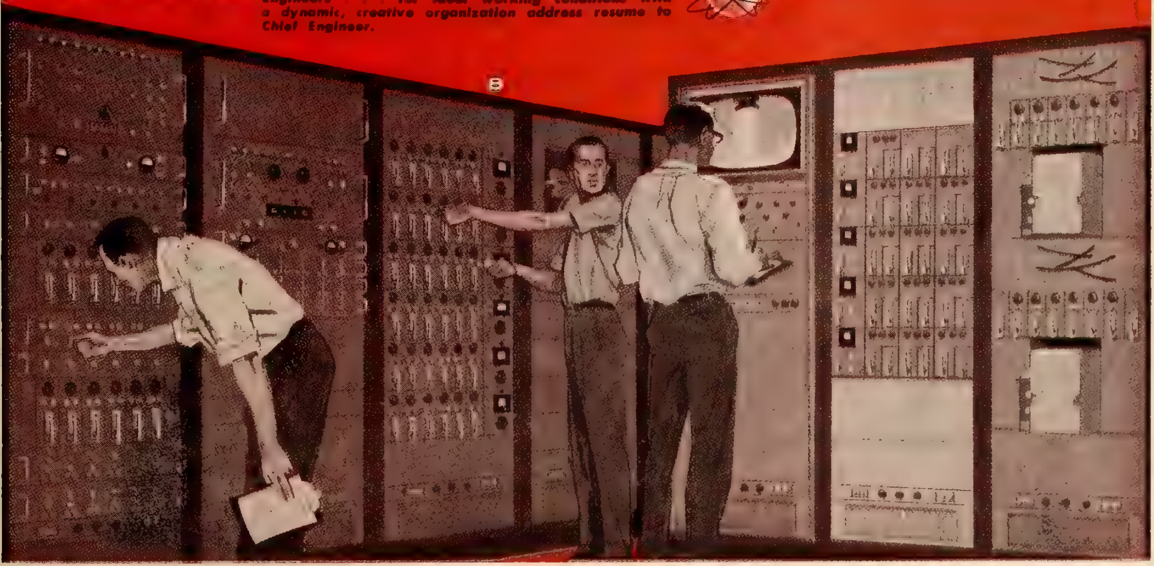

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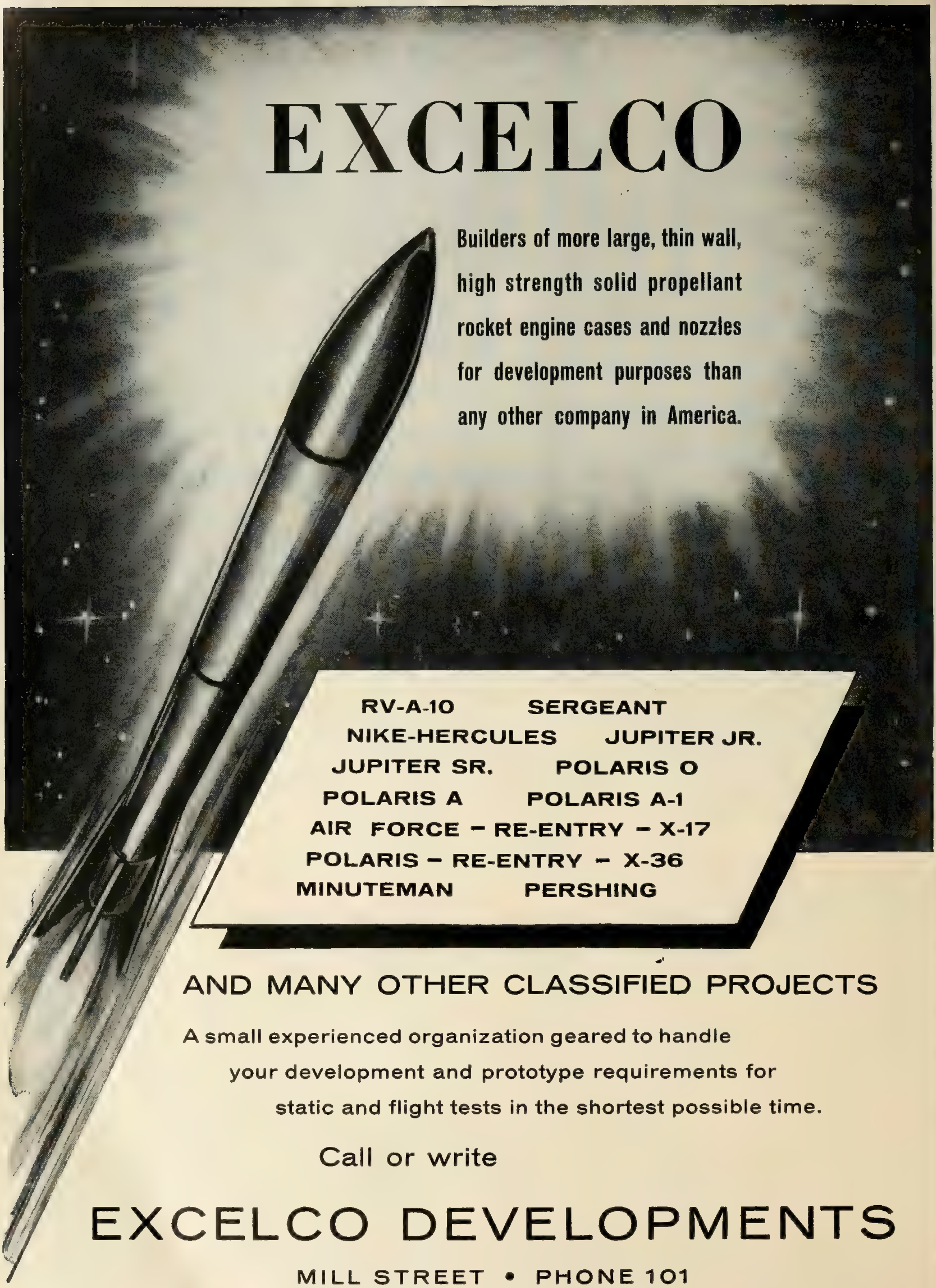

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LOX Systems: Still Problem Area

This principal oxidizer continues to provide troubles that can be solved only by new methods and equipment

By Ernest Edward Lindros*

Before LOX is finally taken aboard a missile at a launching site, as many as four different transfer functions must be completed: from manufacturing facility to mobile trailers, and from the trailers to storage tanks and other points on the launching site itself. Frequency in transfer has made it mandatory that reliable, safe and efficient techniques be developed in handling and transferring large quantities of LOX in the equipment design and storage facilities. An additional problem is the necessity of handling LOX in an extremely short span of time.

LOX becomes dangerous only if incorrectly handled or if exposed to conditions that are unreasonable with any compressed gas or liquid. Under normal circumstances, it is safe and predictable and creates no corrosive or toxic dangers.

• **Transfer Methods**—Two basic methods have evolved in the transfer of LOX from one container to another. In the first, gaseous oxygen (GOX), or another inert gas pressurizes the first storage tank, forcing the LOX into the second. In the second method, pumps transfer LOX from one container to another.

Both of these methods have obvious advantages, as well as disadvantages, and LOX users are still in the process of determining the best system for each specific application. Neither the military nor liquid oxygen users can yet make generalized recommendations since the quantities handled in the past have always been minute compared to today's requirements.

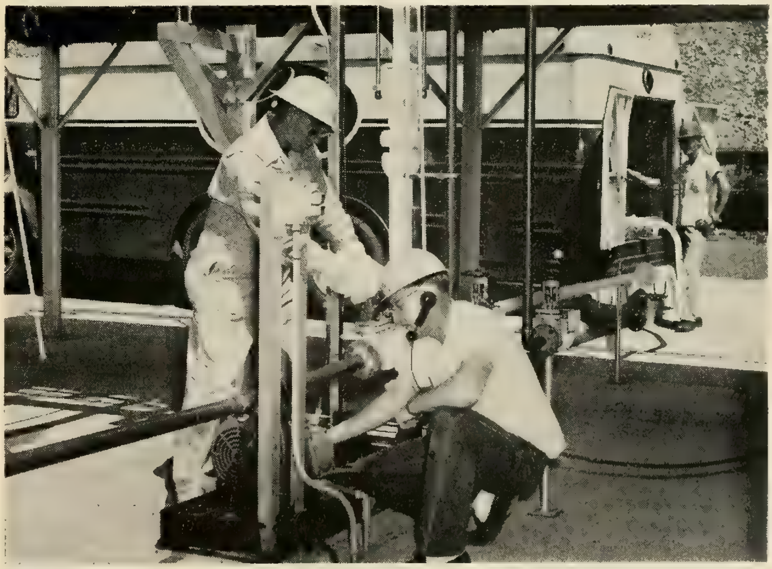
It now seems certain, however, that with the huge missile firing sites now being planned, proper and adequate ground support facilities will soon be standardized. U.S. Government appropriations of almost $2 billion for launching sites and equipment will necessitate a decision in the optimum methods of LOX transfer and fueling.

The tank pressurization technique for missiles dates back to the German V-2 sites. Before that the basic technique was successfully used in chemical and medical fields. Probably the main reason for its early adaption in missile fueling was that reliable pumping equipment for LOX service had not been developed. Such pumps were not required when quantities handled were relatively small and applications few. However, in the missile era, large quantities must be handled quickly and frequently under field or mobile conditions, and positive-action systems based on pumps are felt to be the most reliable answer.

• **Gas Pressurized Systems**—Ideally, the most suitable gas to pressurize a LOX tank would naturally be oxygen itself. There are several drawbacks to this approach. In order to boil off LOX to produce gaseous oxygen, the LOX itself must be allowed to boil off within a container, therefore, pressure within the tank can be obtained only at the cost of allowing the temperature of the entire liquid mass to rise.

This problem has been alleviated to a certain extent by the transfer of a small quantity of LOX to a heat exchanger where it is boiled and converted to GOX. This gaseous oxygen is then re-introduced into the LOX storage chamber without increasing the over-all temperature of LOX. This technique, however, has the inherent disadvantage that it requires exchangers and associated plumbing. Also, this sort of pressurization increases the percentage of GOX bubbles trapped in the LOX. This "aerated" LOX is highly unacceptable and undesirable for missile applications.

Some attempts have been made to get around the gaseous and liquid oxygen mixing problems by pressurizing storage containers with compressed helium or nitrogen. This operation requires separate storage and additional equipment and handling for the compressed gases. However, since nitrogen gas also dissolves quite readily in



TECHNICIANS TRANSFER LOX with pumps from truck to storage tanks at Rocketdyne's Neosho plant.

**Storage and handling of liquid oxygen for the nation's large ballistic missiles has long been a serious problem. While much has been done, more research is still needed before the missile systems achieve a reliable readiness capability. This article by Ernest Edward Lindros, chief hydraulic engineer, Pump Products Division, Byron Jackson Division of Borg-Warner Corp., is particularly timely.*

LOX and a small percentage dissolved in LOX will render it useless for propulsion purposes, the combination is very unsatisfactory.

As storage tanks increase in size and scope, the pressurizing system required becomes more complex. Gas must be introduced at the same rate that LOX is being withdrawn because of the increase in gas volume and the decrease in LOX. Thus, the maintenance of a steady flow rate in emptying tanks by pressurizing with gas presents control problems of complexity.

An additional disadvantage to the gas pressurization system is the tremendous increased cost of the storage facilities. Storage vessels must be capable of withstanding pressures of 100 psi or more. Therefore, both the liquid and the gas storage facilities must be fabricated of thicker metal than required for the pumping system.

- **Pumping system**—LOX users have encouraged a number of engineering groups to devise pumping techniques and equipment that would satisfy rocket launching site needs.

Centrifugal pumps have proven a satisfactory and reliable method for moving cryogenic liquids. One important advantage of this type of unit is that any number of pumps with proper characteristics can be manifolded for reliable parallel operation. The capacity of a parallel system may be controlled by throttling the main discharge line. This causes all units to operate at an equal pumping load at a constant speed. The pumps can be operated over the entire performance range, even back to almost zero capacity, without damage when proper design is provided for internal radial and axial hydraulic force balance.

Experience has shown that standard process pumps, when constructed of metals with the proper impact strengths and sealed by a low temperature seal, are reliable and practical. New seals have been developed making possible the adaptation of process pumps to cryogenic service. To effect the required modifications on process pumps, the equipment manufacturers have had to solve four basic problems:

1) method of pumping low viscosity fluids.

2) large temperature variations.

3) material selection.

4) adequate shaft sealing techniques.

The precise reaction of the low viscosity cryogenic liquids is of prime importance to the pump designer since he must know how to shape and engineer fluid passages within the pump. However, the years of experience gained by the process pump manufacturers in pumping low viscosity fluids such as methane and ethane have provided a wide and useful background of knowledge.

- **Temperature parameters**—Any changes from ambient-temperature to the range of –300°F require that some provisions be made for dimensional changes of mechanical components. When a LOX pump is first filled, it will be at the ambient temperature, but after a certain time in operation some portions of the pump will drop in temperature to that of the LOX itself.

On the other hand, when the pump is shut down, the reverse holds true in that operating parts in contact with LOX will change in temperature to that of the ambient. Therefore, definite provisions must be made in the design to allow for the shrinkage and expansion of operating components.

For example, design engineers have long agreed that when temperature differentials between ambient and fluids being handled exceed 250°F, certain definite provisions in the design must

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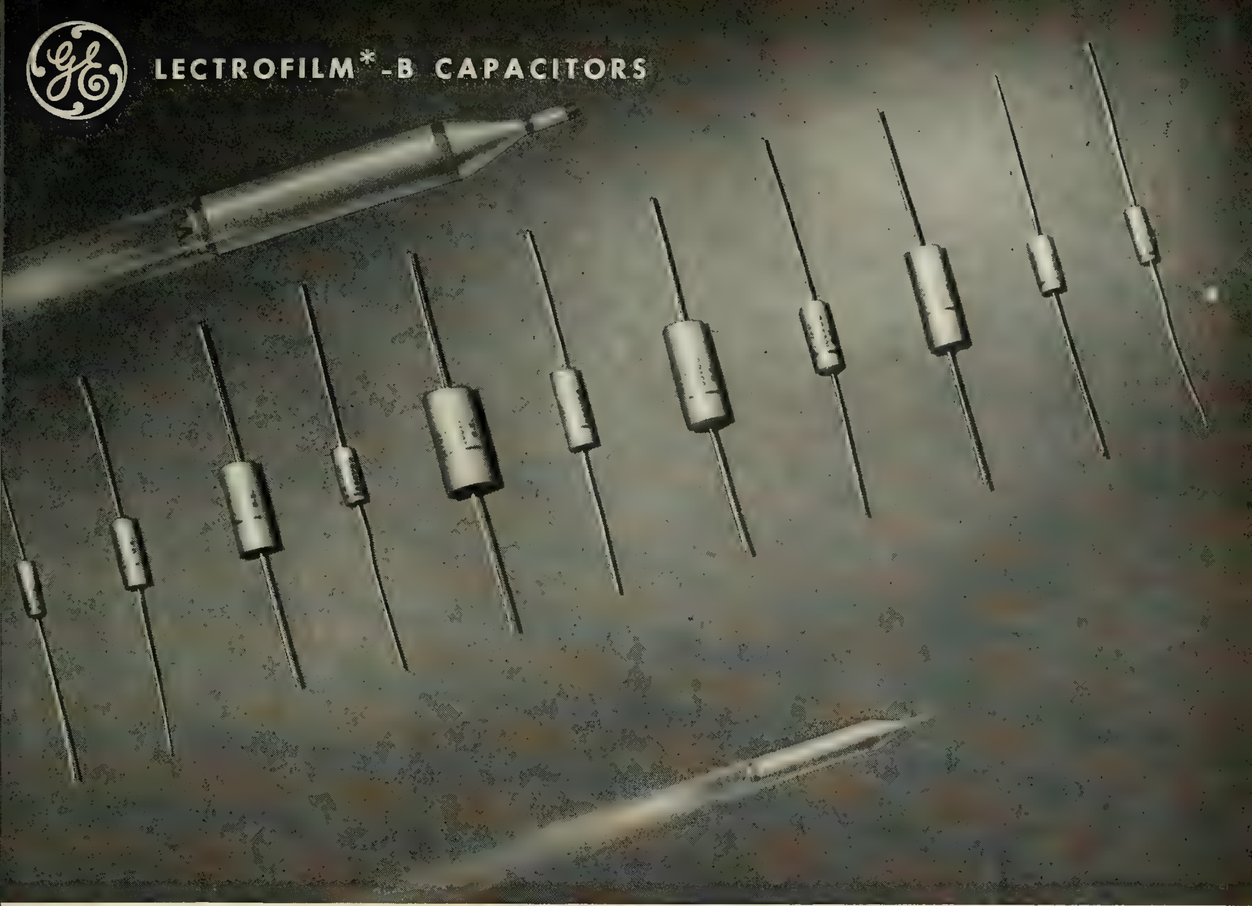

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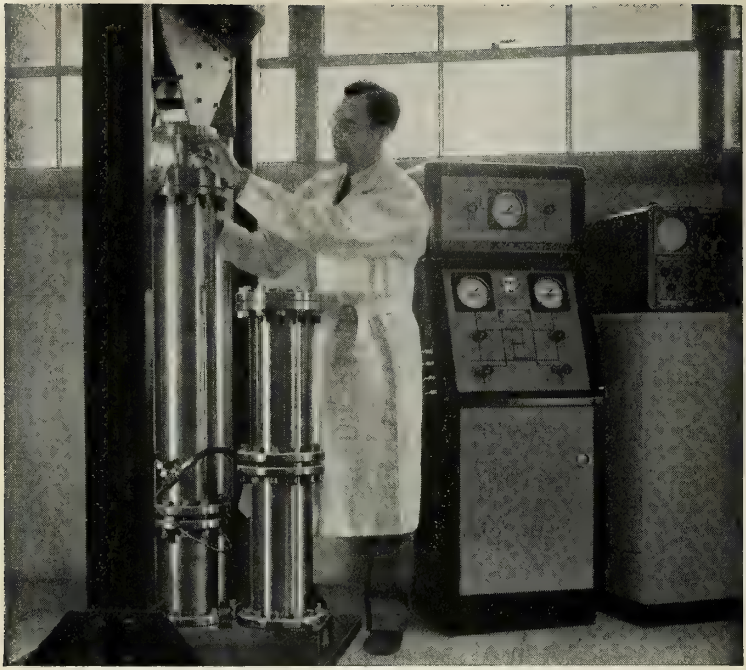

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Bulletin 4-70 gives you much more information on the theory and application of Hyge, including specifications and accessories for the HY-6000 Hyge and the smaller, 10,000 lbf. Hy-3000.

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be made to cope with thermal expansion problems.

Indirectly, the solving of the temperature problems indicated that material selection was not as critical as had initially appeared. The solution centered on the selection of materials that did not become brittle when in contact with ultra-low temperature gases and liquids. Thus, it was decided that conventional metals such as austenitic stainless steels (Type 304), certain aluminum alloys and bronzes were quite acceptable.

While stainless steel offers a distinct advantage in strength over either bronze or aluminum, its added weight makes it less acceptable for mobile installations. Aluminum offers an additional advantage in that there is less boil-off during the start up period. A combination of a relatively low specific heat and density requires that less heat be transferred to aluminum than other metals to cool it down to the temperature of the cryogenic liquid.

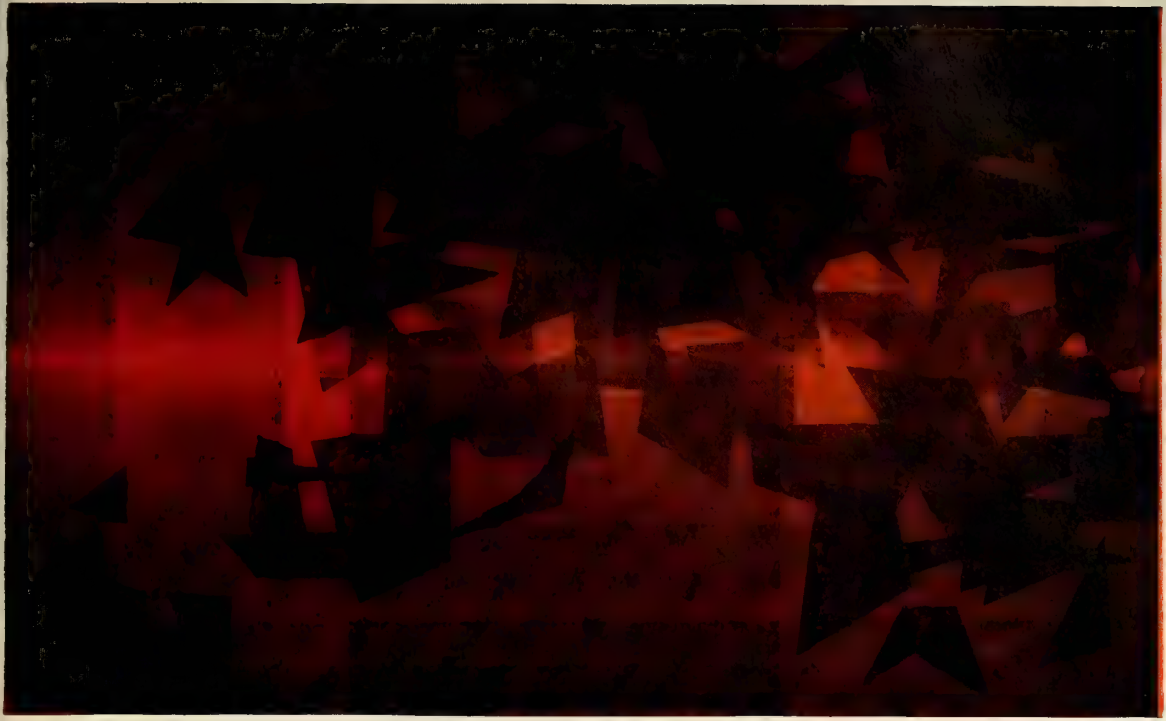
- **Seal Design**—Shaft sealing has presented one of the most difficult problems in completing pump designs for cryogenic liquids. The several methods used for sealing cryogenic pump shafts can be divided into the following four categories:

1) packing against gas.
2) packing against cryogenic liquid.
3) mechanical seal against gas.
4) mechanical seal against cryogenic liquid.

The first LOX pumps used the packing-against-gas technique since it was the only effective type of seal that would work at that stage of development. However, it operated satisfactorily only when stuffing box pressures were low. With pressures above 10 psi, packing became ineffective and excessive stuffing box leakage occurred.

Packing cannot be used to seal directly against LOX because it loses all of its resiliency and becomes rock hard in the range of –300°F. Pumps using packing must, therefore, provide some method of converting liquid to gas at the points where the packing is to be employed. Byron Jackson pumps have an isolation chamber for this conversion.

Liquid oxygen under suction pressure enters the pump, and some of it goes through the shaft sleeve into the nozzle head. Since the nozzle head is considerably warmer than the boiling point of LOX, due to the friction of the seal, a good portion of the LOX vaporizes. Therefore, only a small amount of LOX is contained in the isolation chamber above the pump.



"ECLIPSE" a recent painting by Simpson-Middleman, gifted artistic interpreters of the physical sciences. About this new expression they write: "'Eclipse was painted as a result of watching an actual eclipse of the sun. We were particularly struck with the curious light that was both dim and glowing and the unusual pattern of the shadows on the leaves of the trees around us. We had never seen anything like it before." Painting courtesy of John Heller Gallery, Inc.

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Engineers and scientists at Boeing are at work on advanced projects that include a space weapon system based on a manned orbital vehicle capable of re-entry into the atmosphere and normal landing. This major contract-supported program is a result of recognition of Boeing's space-age orientation, its tremendous technical and research capability and its extensive weapon system management experience.

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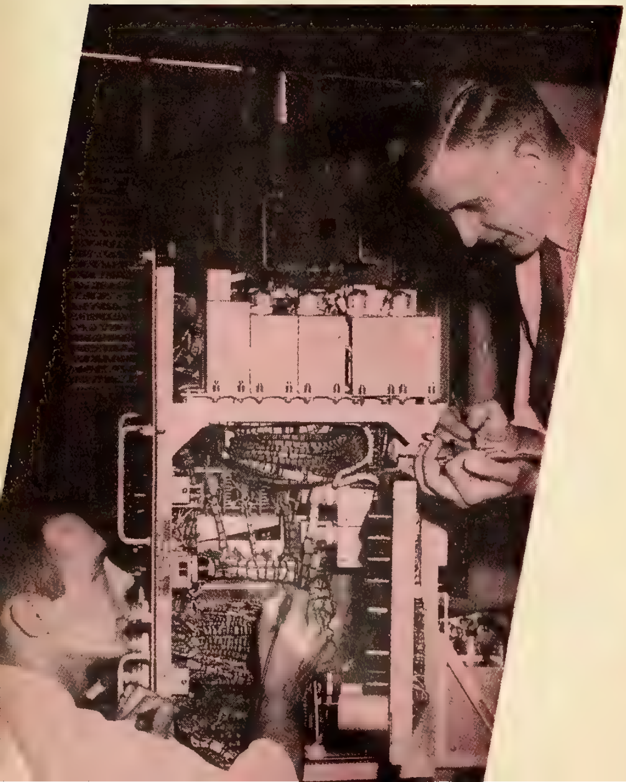

. . . LOX systems

The liquid level is controlled by stuffing box leakage. Proper design keeps the liquid level well below the packing so that the packing seals only against the gas.

Packings suffer from a number of other disadvantages, including the amount of maintenance required. The packing fit on the shaft must be precise. If the packing is too tight, it will seize, overheat, and possibly damage the shaft or packing sleeve. If it is too loose, it will allow excessive leakage.

• **Mechanical seals**—Because of these packing deficiencies, it was quickly recognized that a mechanical seal would prove the most efficient and reliable method. A dry mechanical seal for gas could only be installed in a vertical position and for this reason all early LOX installations featured vertical pumps.

While the liquid seal development was being carried on, another program was in progress for the development of a vertical LOX pump for 1000 gpm at 100 psi. The pump was originally designed with an isolation chamber and packing to seal against gas.

During the manufacture of the pump, the liquid mechanical seal was perfected. The Air Force was so impressed with the test performance of this seal that they requested that the liquid mechanical seal be utilized in place of packing. This was accomplished by using external piping to carry the LOX up to the seal.

Mechanical sealing against LOX is undoubtedly the most satisfactory method at this time and is preferred because it offers all the advantages of reliability and economy. The design has been proven by many months of successful field operation.

• **Vertical Vs. Horizontal pumps**—Due to the non-availability of satisfactory seals in the early stages of development for LOX applications, most centrifugal pumps were vertical units. These incorporated an isolation chamber where LOX could be converted to its gaseous form.

Vertical units are better adapted to effective insulation, and with the added reliability afforded by the liquid mechanical seal, they are more desirable for certain critical or continuous operations. A distinct advantage of the vertical unit is its ability to operate at extremely low net positive suction heads (NPSH), eliminating the need for pressurization and assuring reliability of starting.

One of the basic criteria used in determining the pump type is the

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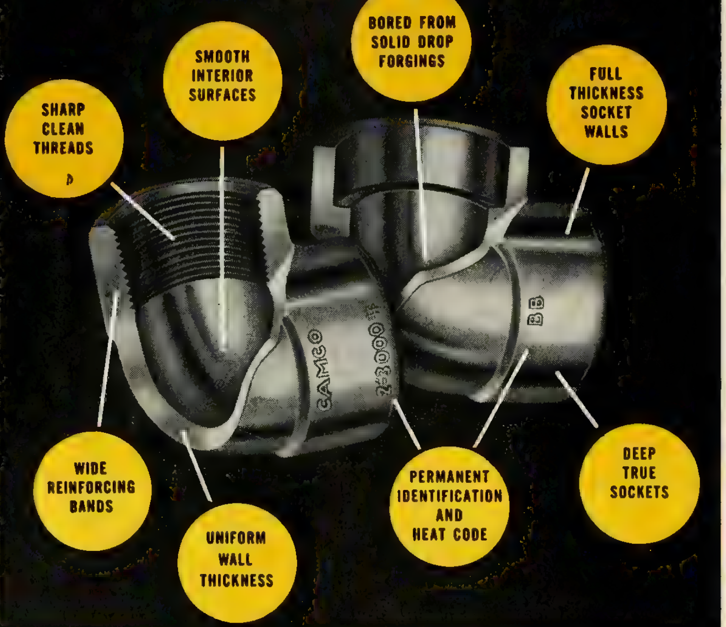

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amount of NPSH available. The available NPSH is the height of liquid above the centerline of the pump impeller that exceeds the vapor pressure of the liquid.

Horizontal pumps incorporating the liquid mechanical seal have now been proven practical for cryogenic fluid service. Due to weight and space advantages, a horizontal unit is more desirable for mobile installations, and in addition offers a substantial first-cost saving plus lower maintenance.

However, horizontal units require more available NPSH than equivalent vertical units. If a horizontal pump is used where tank pressurization is not available, it must be located sufficiently below the tank, either by raising the tank or lowering the pump in a recess to provide the necessary NPSH.

• **Lubricant limitations**—Hydrocarbon-base bearing lubricants are not desirable due to the possibility of explosion in the presence of LOX or GOX. In general, non-hydrocarbon lubricants compatible with the cryogenic liquid being handled are preferred. However, some of these lubricants liberate acids when coming into contact with moisture, resulting in corrosion of bearing surfaces.

Two things have been done to eliminate this corrosion problem. A heating element with thermostatic control is provided around the bearing housing to prevent expansion of air into the housing due to temperature changes. In addition, dry nitrogen gas is injected into the housing to purge out all the moisture-laden air.

In general, design selection of any specific type of pump should depend on its ultimate application and operational considerations. As stated, both types have distinct advantages, and since these are of a complex nature, pump buyers would do well to discuss a pump's selection and performance requirements with pump manufacturer's engineers.

USSR to Produce 400 Science Films

The Soviet Union has announced plans for the production of more than 400 popular science films.

The film titles planned include "Explorers of the Universe" dealing with Soviet rocket techniques; "Television from Earth Satellites"; "Automatons in the Cosmos," on the use of high altitude rockets; "Cosmic Medicine"; and "Four-Footed Astronauts," on the training of animals for flights.

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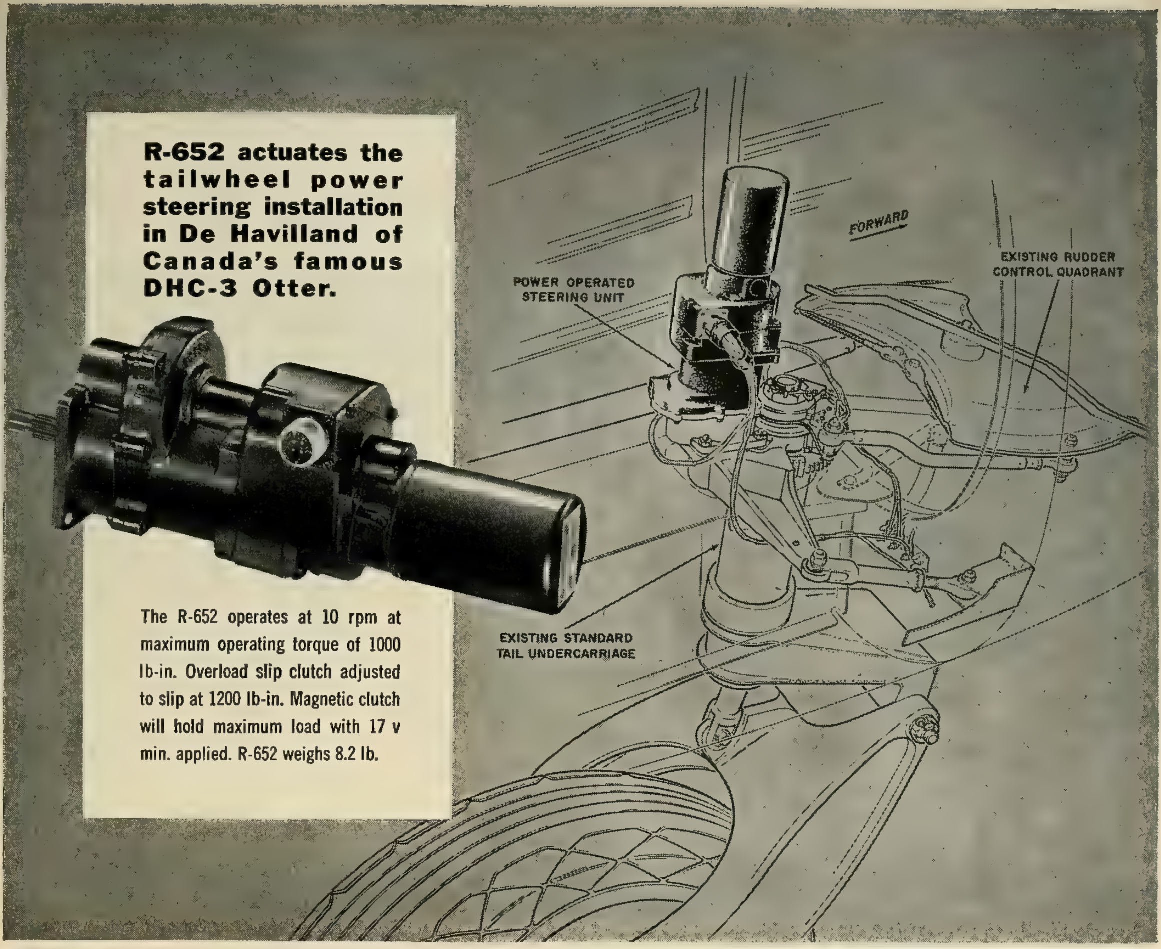

R-652 actuates the tailwheel power steering installation in De Havilland of Canada's famous DHC-3 Otter.

The R-652 operates at 10 rpm at maximum operating torque of 1000 lb-in. Overload slip clutch adjusted to slip at 1200 lb-in. Magnetic clutch will hold maximum load with 17 v min. applied. R-652 weighs 8.2 lb.

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EXISTING RUDDER CONTROL QUADRANT
EXISTING STANDARD TAIL UNDERCARRIAGE

Drawing courtesy De Havilland Aircraft of Canada, Ltd.

Design of Airborne large special actuator proved in rugged bush-line service

First installed on Otter aircraft some five years ago, the Airborne R-652 special design actuator has been subject to almost every conceivable extreme of bush-line operating conditions. Yet despite bitter cold, intense heat, wrenching, pounding and shock, it has proved as rugged and reliable as the Otter itself. Says De Havilland, "We have used this actuator in aircraft all over the world, from the Arctic to the tropics, with very little service trouble."

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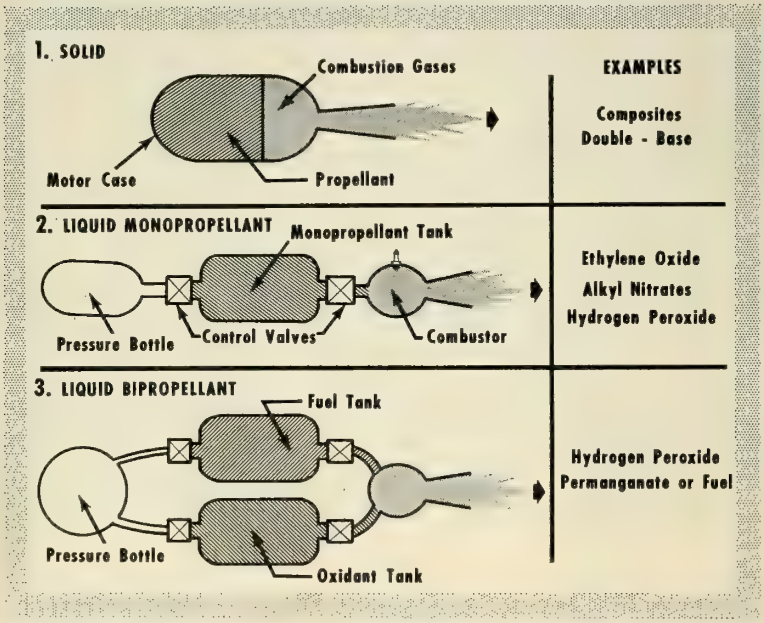
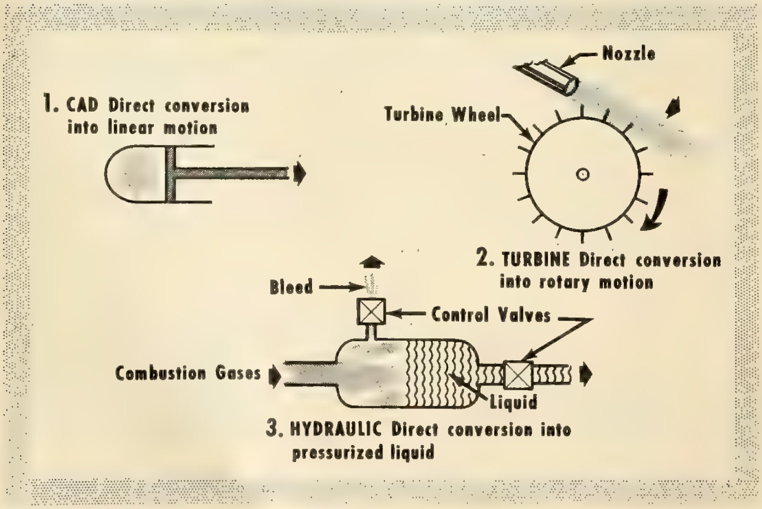
missile electronics

Auxiliary Power Systems Challenge Chemicals

APS Business Should Have Sales of $100 Million by 1970, With Chemical Systems Still Needed for Earth Use



EXAMPLES OF propellant auxiliary power systems.


1. CAD Direct conversion into linear motion
Nozzle
Turbine Wheel
2. TURBINE Direct conversion into rotary motion
Bleed
Control Valves
Combustion Gases
Liquid
3. HYDRAULIC Direct conversion into pressurized liquid

UTILIZATION of propellant power.

by Alfred J. Zaehringer

Large earth satellites, lunar probes, and other long-duration space missions are forcing a serious look at advanced auxiliary sources of power. Steadily increasing power demands for instrumentation, electronics, and even for propulsion systems will see chemical propellants seriously challenged by nuclear, solar, and other non-chemical systems.

Chemical propellants will continue to grow for terrestrial applications such as recoverable satellites, long range rocket aircraft, and high performance ballistic missiles.

Thus, by 1970, the auxiliary power business, chemical or non-chemical, will have hit the $100 million per year sales level. What chemicals will lose in space auxiliary power systems (APS), they will gain for earth use.

•**What they are**—Chemical APs are illustrated in an accompanying figure. Sketch, left, shows the simplest, and theoretically the most powerful from a weight or volume basis—the solid propellant system. With no moving parts, combustion is "pre-programmed" by choice of chemical and ballistic properties of the propellant.

Reliability is 99% or better. One cartridge-actuated device (CAD)—the solid propellant trigger for nuclear weapons—has established a record for only three misfires in ten million runs. Present problems are concerned with improving gas generating efficiency while reducing the flame temperature. Typical flame temperatures now run from 2,000° to 5,000°F.

Another concern is obtaining decomposition gases that can be utilized for direct pressurization of liquids (viz., liquid rocket propellants).

RMI, Frankford Arsenal and the French Vernon Labs are working in this vital area. Solution of this problem would allow simple, storable, and highly reliable small liquid propellant rockets. It is interesting to note that solids will

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thus help liquids to "compete" with them for small rockets—heretofore an almost exclusive domain of solids.

An accompanying drawing outlines the typical liquid monopropellant APU: Gas from a pressure bottle forces the liquid monopropellant into the combustion chamber. Most liquid monopropellants that are safe enough to handle do not have the performance or reliability exhibited by solids. A good monopropellant APU is being used in the Sundstrand ethylene oxide system for *Atlas*.

An accompanying illustration is an example of the bipropellant system. A miniature rocket motor, the hydrogen peroxide-permanganate unit used on the V-2 and current US ballistics missiles, has achieved a good deal of success for powering turbo-pumps.

Tables 2 and 3 give a line-up for US groups working in the auxiliary power area. Table 1 is a glossary of current terminology.

Table I
Glossary of Auxiliary Power Terminology

APS	Auxiliary Power System. Any non-propulsive system, usually self-contained, used to provide mechanical, hydraulic, or electrical power for missiles, rockets, spacecraft, aircraft. Includes power generator, controls, and all operating parts & components.
APU	Auxiliary Power Unit. Same as above.
CAD	Cartridge Actuated Device. Usually a rechargeable APS using a solid propellant or propellant explosive.
GG	Gas Generator. Used to provide a source of gas, usually resulting from the combustion of a solid or liquid propellant.
Hot Gas Systems	Motors, valves, turbines, pistons, servos, etc. which can operate directly from power of hot combustion gases.
Propellant	A self contained combustion system—solid or liquid—(monopropellant or bipropellant). Used to furnish hot gases suitable for work. The term propellant includes both oxidant and fuel. Propellants furnish power at rates lower than propellant explosives.
Propellant Explosive	Usually a solid explosive that can detonate or explode and deliver energy at a very high rate.
Squib	A heat sensitive device, initiated usually by electrical energy, which furnishes hot gases or hot solids which can ignite other propellants.

•How they work—Once we get energy from the propellant (viz., hot, high-pressure, high velocity gases), it must be converted into satisfactory form for work.

Small amounts of energy can be transformed directly into linear motion by the rapid detonation of explosives in cartridge-actuated devices (page 30). This system offers extremely high power-to-weight ratios and appears attractive for operation of landing skids, flaps, etc. in manned rocket aircraft. Other rocket applications include staging and warhead separation in ballistic missiles.

One of the most popular methods of converting the linear motion of exhaust gases into rotary motion is through the use of a hot gas turbine.

Though present units are capable of operating at high turbine speeds, a limiting factor is that of temperature. Most hot gas turbines experience serious difficulties with operation above 1,600°F. There are "cool-burning" solid and liquids below 2,000°F. High performing solids and liquids, however, operating at 3,000° to 5,000°F, pose serious engineering difficulties in hardware development. Clearly, a materials and/or propellant breakthrough is needed here.

A method of converting propellant energy into hydraulic power would be extremely useful for pressurizing liquid rocket propellants or elimination of present accumulator systems. Of course, once rotary motion has been produced, electrical power (through the use of an alternator or DC generator) or hydraulic power (through the use of a pump) is available.

Problems are compromised—Some of the problems that face designers of APU's are things like the compromise with performance, structural limitations and reliability that must be considered for proper turbine diameter and shaft speed. Shaft speed is generally limited to somewhere around 60,000 rpm to attain proper bearing life and unit reliability.

Missile turbine power unit performance is roughly proportional to turbine peripheral speed so the largest possible turbine diameter for any given shaft speed is the most desirable. In actual practice, peripheral velocities are limited by structural considerations to 1000 to 1200 feet per second. Wind-

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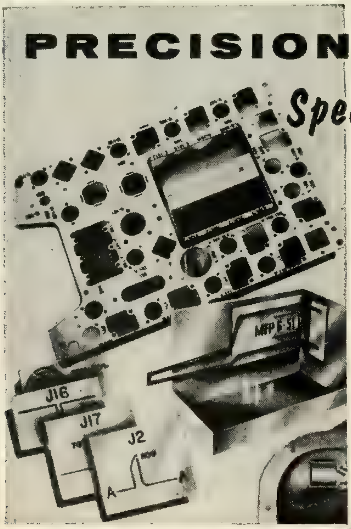

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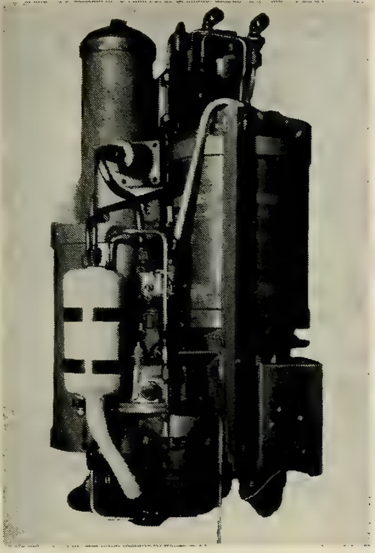
Power Supply Unit



THIS AMF hydraulic power supply weighs 69 pounds including propellant and fluid. The accumulator power supply it replaces weighed 175 pounds. Dimensions are 14 in. long, 12 in. wide, and 26 in. deep.

age losses and package size also impose restrictions.

If you consider the gas generator of a propellant gas turbine as a small rocket motor in which the exhaust jet is directed at the blading of a turbine wheel (which supplies torque to the turbine shaft), the selection of a proper type is clearer.

For times of 60 seconds or less, solid propellant generators are simpler and more compact. Of course, all solids have the disadvantage of no control over stopping and starting if an irregular duty cycle is required. Grain size also can become a problem where space restrictions exist.

Gas generators better—Liquid monopropellant gas generators are better. They allow considerable flexibility in packaging since the fuel container does not have to adhere to a fixed size. Operation is as simple as turning the fuel supply on or off. There are disadvantages such as high weight in relation to burning time and complexity of the system, but these are generally easy to live with when the application calls for a system of this type.

Looking into the future, some of the areas which need (and are getting) investigation are the research of elastomers for seal and fuel-expulsion systems with commonly used mono-propellants, the evaluation of mono-propellant characteristics and the research of ultra-high speed rotating machinery for bearings and lubrication at extreme tem-

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3. *Research Engineer:* B.S. degree in nuclear engineering. College work in general powerplant design.

4. *Engineering Specialist or Senior Engineer Research:* M.S. or equivalent, with a strong background in hydrodynamics and fluid mechanics to study basic relationships of propulsion equipment for air vehicles.

5. *Senior Engineer Research or Engineering Specialist:* PhD. desired with a background in nuclear energy, servo mechanism, controls or instrumentation. Should have preferably 4 years' additional experience.

6. *Senior Engineer Research:* PhD. or M.S. degree with a background in heat transfer relating to gas or liquid cooled nuclear power plants, preferably of aircraft type.

7. *Senior Structural Engineer or Stress Analyst:* Several years' experience in mechanical stress and structural analysis. M.S. or B.S. degree or equivalent.

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peratures.

Another item is the development of high-speed hydraulic pumping machinery so that it is not necessary to use a gear box for driving a pump with a high speed turbine. Considering all the problems the missile program has had with gearboxes in the past year, this last development would probably be welcomed more than any other.

In the selection of an auxiliary power unit for a missile, few "rule of thumb" criteria can be applied. In almost every instance, the power unit is so completely integrated into the missile system, physically and functionally, each power unit is "tailor-made" for the particular application. Similar problems are true for other phases of the electronics-missile industries, whether it be for ground support equipment, or hardware itself. The problem will still carry over into manned space flight, which means that standardization will be virtually unachievable in these vital components.

Companies Involved in APS

Table 2
Auxiliaries for the Auxiliaries

Firm & Location	Products
Atlas Powder Co., Wilmington, Del.	Squibs, explosives
Bermite Powder Co., Saugus, Calif.	Black powder, igniters
E. I. duPont de Nemours & Co., Wilmington, Del.	Squibs, explosives
Hercules Powder Co., Wilmington, Del.	Squibs, explosives
Remington Arms Co., Bridgeport, Conn.	Propellant explosives
Picatinny Arsenal, Dover, N.J.	Propellant explosives

Table 3
The APS Scene in the United States

Firm & Location	Type	Products
ABMA, Huntsville, Ala.	L	APS, hydrogen peroxide
Aerojet-General Corp., Azusa, Calif.	S&L	APS, composites, double base, liq. monoprop., CAD
Allegany Ballistics Lab.	S	APS, CAD, double base
American Rocket Co., Wyandotte, Mich.	S&L	APS, CAD, composites, liquids
Amoco Chemicals, Seymour, Ind.	S	APS, solids (composites)
Armour Res. Found., Chicago, Ill.	S&L	APS, CAD
Astrodyne, Inc., McGregor, Tex.	S	APS, composites
Atlantic Research Corp., Alexandria, Va.	S&L	APS, CAD, composites, gels
Buffalo Electrochemical, Buffalo, N.Y.	L	APS, hydrogen peroxide
Experiment, Inc., Richmond, Va.	S	APS
Garrett Corp., Los Angeles, Calif.	S&L	APS, APS
General Electric Co., Schenectady, N.Y.	S&L	APS
Grand Central Rocket Co., Redlands, Calif.	S	APS, CAD, composites
Frankford Arsenal, Philadelphia, Pa.	S	APS, CAD
McCormick-Selph Associates, Hollister, Cal.	S	APS, CAD
National Northern Co., West Hanover, Mass.	S	APS, CAD
Olin Mathieson Chemical, E. Alton, Ill.	S&L	APS, CAD, composites, double base liquid fuels
Phillips Petroleum Co., Bartlesville, Okla.	S&L	APS, CAD, liq. monoprop.
Propellex Chemical Corp., Edwardsville, Ill.	S	APS, CAD, composites, double-base
Rocketdyne, Canoga Park, Calif.	S&L	APS, turbopumps, etc.
Rohm & Haas, Redstone Arsenal, Ala.	S	solid propellants
Reaction Motors, Inc., Denville, N.J.	S&L	APS, composites & liquids
Southwest Research Inst., San Antonio, Tex.	S	APS
Standard Oil Co. (Ind.), Whiting, Ind.	S	APS, composites
Stauffer Chemical, Buffalo, N.Y.	L	monopropellants
Sundstrand, Pacoima, Calif.	S&L	APS
Thiokol Chemical Corp., Trenton, N.J.	S	APS, composites
Thompson Products, Cleveland, Ohio	S&L	APS, solids, gels
Universal Match, St. Louis, Mo.	S	APS, CAD
USNARTS, Dover, N.J.	L	monopropellants
USNOTS, China Lake, Calif.	S&L	double base, comp., monoprop.
US Naval Propellant Plant	S	propellants
Vickers, Inc., Detroit, Mich.	S&L	APS, hot gas systems
Wyandotte Chemical, Wyandotte, Mich.	S&L	solids & liquid monoprops.

GROWTH OF THE auxiliary power systems is reflected heavily in these tables of companies active in this promising field. The large, the small and the medium-sized companies are involved. The table is not conclusive, but is merely representative of the scope of activity in auxiliary power systems field.

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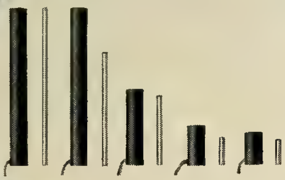


DISPLACEMENT

LINEARSYN Differential Transformers

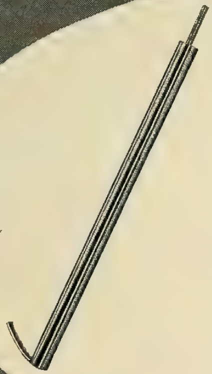
Six series of Sanborn Linearsyns — three of the shielded type, three unshielded — are available, with five models in each series. Linearity is better than 1% of full scale output in all models. Temperature range is from −50° to 205°F.

Special design features include coil assemblies hermetically sealed in epoxy, laminated phenolic jackets (unshielded types) or heavy plated steel jackets (shielded types), improved lead wire strain relief, high permeability alloy cores. Models with axial leads are also available on special order. Within each series all models have identical diameters, tap sizes, lead wires; only the lengths of coil assemblies and cores vary.

Typical Linearsyn Characteristics

Series* (Unshielded)	Series* (Shielded)	Strokes* (±Inches)	Freq. Ranges	Sensitivities* (Volts/inch per volt of excitation at std. carrier freq.)
575DT	585DT	.050 - 1.00	400 cps - 10 kc	.56 - 3.70
576DT	586DT	.050 - 1.00	60 cps - 400 cps	.70 - .90
590DT	595DT	.005 - .100	400 cps - 20 kc	1.60 - 2.60

*Maximum and minimum values available within each series; data on individual models on request.



VELOCITY

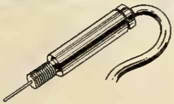
LVsyn Velocity Transducers

LVsyn pickups may be used to measure *linear velocity* directly, *displacement* with a simple integrating circuit, or *acceleration* with a differentiating circuit. There are twenty-four models, all self-generating with shielded cylindrical coil assemblies and high coercive force permanent magnets. Twelve models use regular magnet cores; twelve have *non-breakable* magnet cores. Characteristics of the two groups are the same except for output sensitivity, core length and weight. Features include high sensitivity, single-ended or push-pull output, accurate and stable calibration, unlimited resolution, wide range of sensitivities and sizes, temperature range of −50° to 200°F. They can be immersed in hydraulic fluid. No mechanical connection between coil and core permits low friction level. End stops or displacement limits not needed; undamaged if limits are extended.

Typical LVsyn Characteristics

Model	Displacement		Electrical Characteristics		
	Nominal Working Range (Inches)	Maximum Usable Stroke (Inches)	Voltage Output mv/inch	Total Impedance Series Connection R ohms	Total Impedance Series Connection L henrys
3LVA5*	0.50	1.30	120	2,000	0.085
6LV2*	2.0	3.4	500	19,000	2.4
6LV2-N	2.0	3.4	250	19,000	2.4
7LV9*	9.0	11.0	350	17,000	2.8

*Four of the twenty-four models available, selected to show minimum, approximate mid-range and maximum working ranges as well as the difference in sensitivity between a regular magnet core model (6LV2) and a non-breakable magnet core model (6LV2-N).



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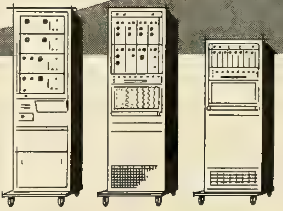

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Power In Space: New Developments Seen Promising

by Peer Fossen

With the missile and space era came demands for new and better electrical batteries, both for ground use and for auxiliary power applications in missiles and satellites. Stimulated by this demand, scientists set out to come up with what was asked for—long-life small units with high efficiency—and an enormous amount of money together with tens of thousands of man-hours was poured into improvement of existing batteries and research and development of new devices. However, although there has been a steady progress along these lines, much remains before the ultimate in the field is attained.

Power systems for missile, rocket, satellite and space craft electronics can be divided in three main groups according to the mode in which they derive their energy:

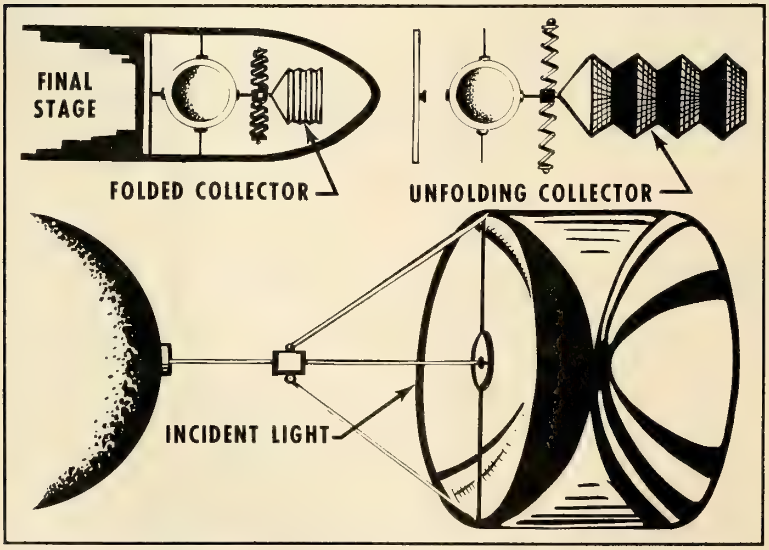
(1) Electrochemical
(2) Solar
(3) Nuclear

This article will review some of the more important within each category over the past few years, and discuss what can be expected in the future.

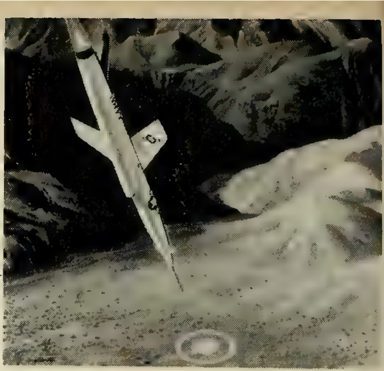
Electrochemical Conversion—One of the oldest members of the electrochemical battery family, the dry cell, is still widely used for missile and research rocket applications, since these vehicles normally are intended for a one-shot deal, and require power for short periods only.

The electrochemical field, however, has seen two important developments during the past few years, viz; the zinc-silver oxide cells and the hydrox fuel cells, both types suitable for missile applications.

Zinc-silver batteries are widely used as airborne electrical sources because of their high energy output, excellent voltage regulation and relative small size and weight. To gain maximum power at the time of activation these batteries are stored in a dry-charged



EXAMPLES of proposed systems to obtain larger amounts of solar energy.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Telemetry Engineer. B.S.E.E., or M.S.E.E., with 5 to 6 years experience in the electronics of telemetering. To guide R & D in the design and application of electronic data.

Applied Mechanics Engineer. M.S.A.E., or M.S.M.E., with 5 to 6 years experience in structural load analysis, dynamic analysis, vibration, stress analysis, applied math, or inertial instruments. To conduct R & D in instrumentation dealing with applied mechanics.

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C. A. Besio
Supervisor, Engineering Personnel
Dept. P-7

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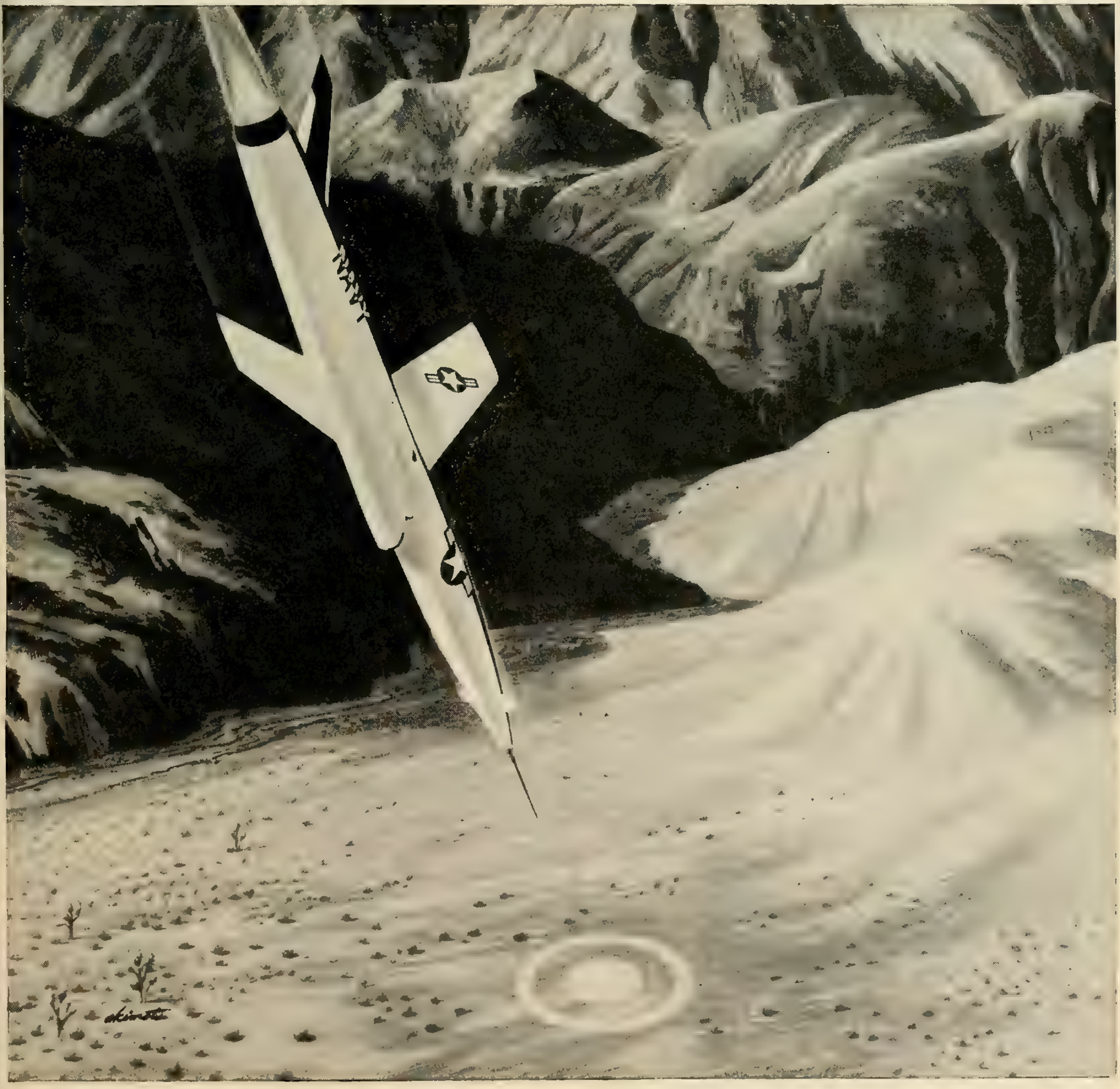

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Background should qualify for planning and formulating entire flight test programs.

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Must be able to analyze missile configuration to determine aerodynamic performance and stability and control characteristics.

For information on these and other engineering positions, write:

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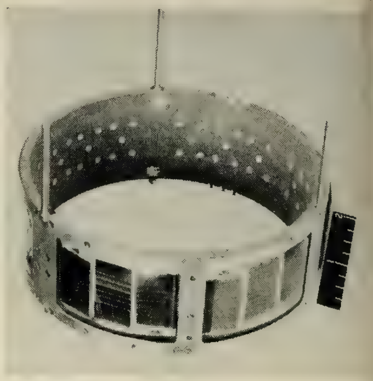


EXPLORER **SOLAR ring could deliver as much as one watt of power if all cells were illuminated at the same time.**

condition and liquid electrolyte is added just before the battery is used.

The theoretical maximum performance of the zinc-silver battery is 176 watt-hours per lb. At the present time, on the order of 50% of this performance is available.

Originally, electrolyte was manually added to the individual cells. To overcome the disadvantages of hand filling, automatically activated Zinc-silver batteries have been developed.

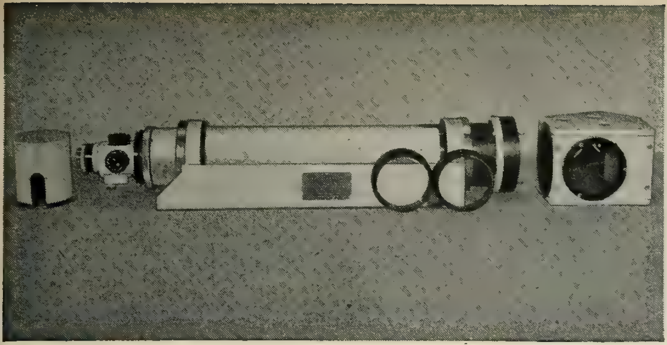
Automatically activated silver-zinc batteries consist of a dry-charged battery pack and an activator containing the electrolyte and a device for moving the electrolyte from a reservoir into the pack. Some method of heating the battery is also needed to permit effective operation at low temperatures.

The hydrox cells—also known as fuel cells—work on a principle which is basically a reversal of the process of electrolysis of water. That is, the hydrogen used as the fuel is oxidized to water, and electrical energy is produced. The hydrox battery has a substantially higher theoretical maximum performance than the zinc-silver device—on the order of 1700 watt-hrs per lb.

The currently available performance is approximately 300 watt-hours per lb. and 3 watt-hours per cubic in., including the weight and volume of the containers for the feed-gases needed to operate the system. Work is being carried out to develop containers of materials with high strength-to-weight ratio.

The 300 watt hour per lb. performance was achieved with liquid oxygen stored at 600 psi and hydrogen at 6000 psi. With light weight containers the watt-hours per lb. figure would have been considerably higher, maybe as much as 150%.

The zinc-silver and hydrox cells



Problem To align radar antennas with extreme accuracy.

Solution Kollmorgen 30X Collimator.
Measures *within a pencil's width* at a mile.

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The various instruments on this page all have one purpose in common—they allow the observation and measurement of objects which it would otherwise be impossible to see in detail. In bunkers, under water, in the absence of light, in the presence of radioactivity and under many other adverse conditions, Kollmorgen remote viewing instruments have brought the eye of the observer to the heart of his problem.

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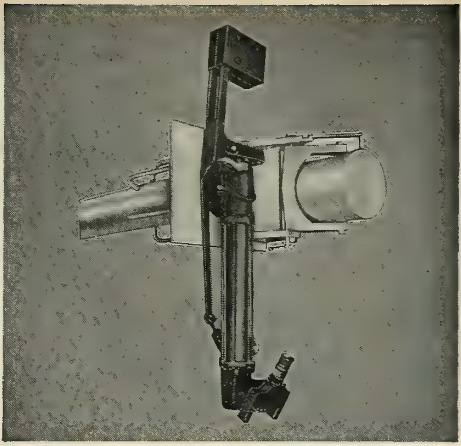

Problem Remote viewing in the presence of harmful radiation, heat, pressure, water or toxic gases.

Solution Kollmorgen Wall Periscopes with non-browning optics, corrosion-resistant materials, 180° scanning.

Problem Detailed, long-range observation at sea under varying weather conditions.

Solution Kollmorgen 20X, 120 Ship Binocular. Wide, bright field. Hermetically sealed, super lightweight.

Problem Internal inspection of inaccessible areas of tubing, long bores, machinery, engines, aircraft structures.

Solution Zeiss-Kollmorgen Self-illuminating Borescopes. Diameters from .100", lengths to 45 feet. Bright, clear field.

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are only two of many developments within the electrochemical field important to missile and satellite power requirements. Other projects currently in the research stage include lead-silver oxide, iron-silver oxide, zinc-nickel dioxide, and cadium-mercuric oxide batteries.

Solar Conversion—On October 17, the *Vanguard* I satellite had been in space for seven months. That in itself is a milestone since no other man-made satellite has been orbiting that long, but of equal significance is the fact that one of its radio transmitters is still in operation, and that the power used to operate this transmitter is generated in outer space.

The satellite utilizes six solar clusters, each containing 18 cells, distributed over the surface of the sphere in such a manner that the equivalent of one cluster is always turned toward the sun. The solar cells, developed and produced by Hoffman Electronics and made into clusters at the U.S. Army Signal and Development Laboratory, work on the photo-voltaic principle by which light energy is converted directly into electrical power, without the intermediary of rotating equipment.

The second transmitter in *Vanguard* I, as well as the transmitters in our *Explorers* and Soviet *Sputniks*, with the exception of *Sputnik* III, were supplied with power from conventional batteries and ceased operation after only a few weeks in space. *Sputnik* III, which was launched on May 15 this year, and which is reported to be equipped with solar devices for generation of power, is also transmitting at the present.

- *Vanguard* **is first**—The *Vanguard* solar energy converter undoubtedly will be remembered as a "first" in the history of science, but it and other photo-voltaic systems are far from the ultimate in solar conversion in their present state for satellite and spacecraft application. The main drawbacks are fairly low efficiency and sizeable weights. The units being produced at the present operate at an efficiency on the order of 10 to 11%. Another problem is the high cost of materials used in the manufacture.

There are many research projects underway to explore new materials to overcome the inefficiency in present solar cells and to develop new and improved methods for clustering these cells to obtain more electrical energy.

This article shows two possible methods for drawing more of the power the sun has to offer.

For example, there is a satellite,

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MAGNETIC TAPE TESTS

17

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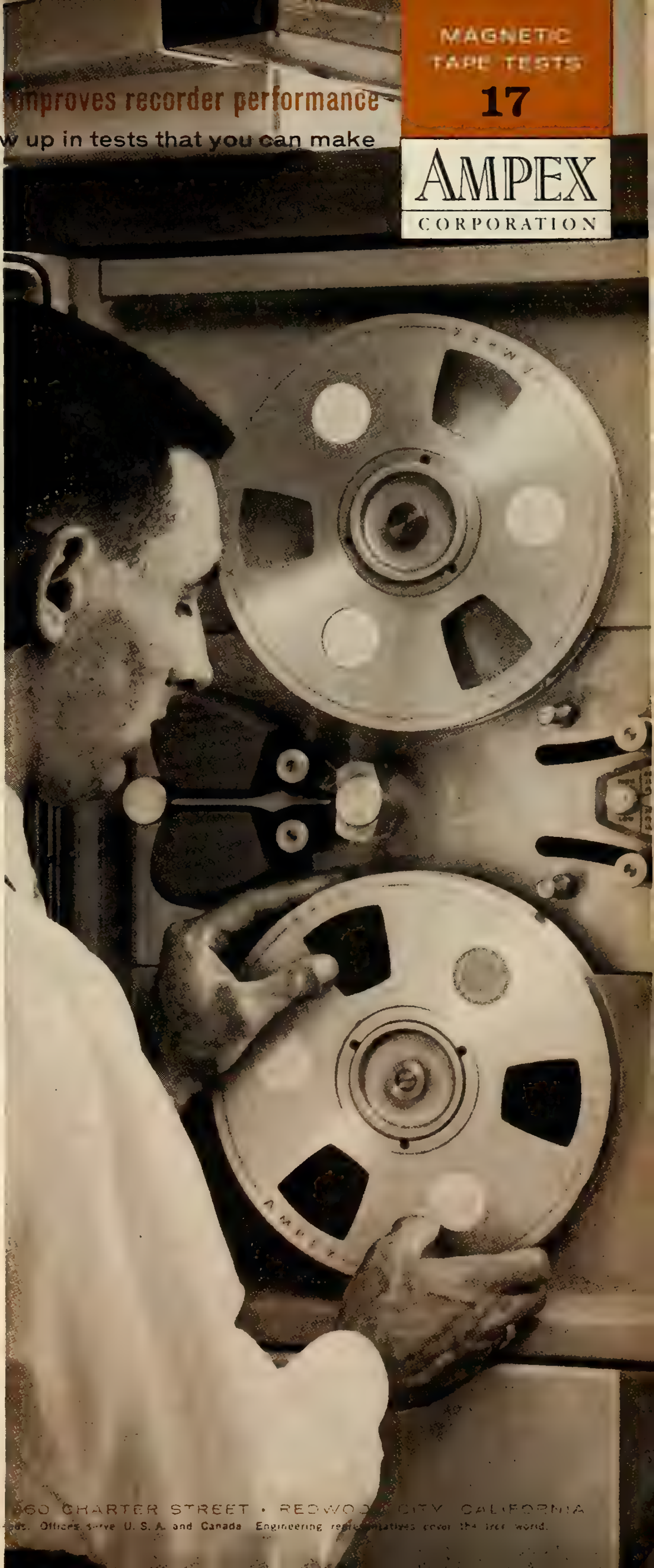
AMPEX INSTRUMENTATION TAPE improves recorder performance

Some significant differences will show up in tests that you can make



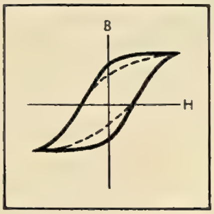
It's like buying premium gasoline to get the most out of a new 10-to-1-compression automobile engine — (except that this is the deadly serious business of collecting elusive facts). After you've acquired the best instrumentation tape recorder you can buy, you will get the most out of it by using the best tape that knowledge and skill can produce. In instrumenting a jet engine, programming a computer or firing a missile, great sums are expended solely for the data they produce.

By comparison, a small extra price you pay for Ampex's premium-quality tape shrinks to insignificance. Highly tangible differences in Ampex Instrumentation Tape are a smoothness of surface, squareness of hysteresis curve, and precision of reel. The latter is optional — usually well worth its price.

EXTRA SIGNAL-TO-NOISE RATIO

In direct recording the tape generally determines signal-to-noise ratio. This is of particular importance on frequency-multiplexed data where combined peaks can result in high signal levels. Unless the tape has exceptional qualities, the consequent intermodulation distortion gives severe interchannel interference and signal degradation. Ampex attacks the problem on both ends, extending the linear portion of the tape's recording curve and reducing noise components.

The hysteresis curve of a magnetic tape is the key to this extended linearity. Call it the tape's personality. It can sluff over in a lazy curve, or like Ampex tape it can sit up straight and square. The effect is easy to measure and compare. Set your recorder for optimum bias for each tape. Then record increasing signal levels until 1% third harmonic distortion is measured. One of our published papers gives full details.



And about the noise. Amplitude modulation is an important source that we can reduce. On sine waves it looks like whiskers on the peaks. It is due to incremental variations in effective magnetic characteristics — whether caused by changes in coating thickness and composition, or by surface roughness that lifts the tape slightly away from the heads. Ampex pays special attention to oxide preparation and coating techniques. And the exclusive Ferrosheen process gives a smooth polished surface. For a test comparison, saturate sample tapes in one direction. Then measure the comparative noise levels on playback.

FM-carrier recording and NRZ digital are also improved by tape-surface smoothness and Ampex's squareness figure of merit—(subjects for future numbers in this series). In the meantime if you like your facts in depth and want to make your own tape tests, we would be pleased to send our recently published technical papers on tape. A technique for setting optimum bias is included and will be particularly useful. Write Dept. B-17.

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together with a folded, solar-cell covered collector contained within the nose cone of a missile. The satellite and collector are ejected at the same time and the collector is expanded, exposing the large solar cell surfaces to the sun. A design such as this can be developed to deliver up to several hundred watts.

The second method, involves concentrating light on a small number of solar cells. This would result in a major increase in electrical output. The system consists of a supporting container—expanded by gas pressure after ejection—which holds simple reflectors that focus the incident solar rays on the active solar converter surface. The effect would be the same as having the reflecting surface covered with solar cells.

There are several projects in the research stage which would completely abolish the solar cell for power conversion. One of the most interesting is the photoelectric generator being developed by the Astronautics Institute of the Westinghouse Air Arm Division. (The basic principles of this generator were described in m/r, Sept. 22, 1958, p. 15).

• Design is flexible—The design of this device is extremely flexible, and the generator can be made in any size and power category—within practical engineering limits.

For satellite and space-craft applications, the sun-ray collecting surface of the generator apparently will be some inflatable device of round shape trailing the vehicle, with dioxide used for inflation. By using the round shape, the problem of proper orientation is eliminated.

The maximum theoretical conversion efficiency for the photoelectric converter appears to be about 25%, which would mean power yields of about 375 watts per square meter. A crude working model in the Westinghouse Laboratories has performed at efficiencies of about 1/10 of one percent. Efficiencies of a few percent are expected before long, and a 10% efficiency will perhaps be attained within one year.

• Nuclear conversion—The interest in finding methods to convert nuclear energy into electrical energy for auxiliary power application in space has grown tremendously over the past few years. The interest is shared equally by industry, research organizations, universities, branches of government and the military services. Much good work has been accomplished in the nuclear field, and according to Congressional testimony earlier this year, the project of providing nuclear auxiliary power for space vehicles (*Rover, Pluto* and *Snap*) looks promising.

Several types of nuclear batteries have been developed and are available, but their use is limited to applications with extremely low power demands, since they supply only a few microwatts. Some of the conversion methods in these batteries are:

a) direct charging (high impedance and low current); b) contact potential difference (very low efficiency); c) semiconductor junction (higher current and lower impedance than the direct charging type, but having short life); d) thermo junction (low efficiency and short life); or e) photovoltaic (constant voltage).

In spite of the fact that many problems have been solved in connection with nuclear conversion, there is still much work to be done, especially for devices to answer high power demands.

High on the list of unsolved problems is that of shielding, which presents an obvious drawback, particularly to small space vehicles. Much effort is being put into projects tending to rectify this situation, and hopes are that the weight problem will be re-

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Outstanding scientists and engineers who were currently working on missiles and space problems in these divisions have been brought together in this new organization. They are working as a closely interlocked team to focus their combined skills on advanced air-space concepts and systems.

Only months old, this new division is already in an explosive period of growth. Already there is an immediate need for more . . . many more . . . scientists and engineers who want to specialize in the newest aeronautical sciences.

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An invitation
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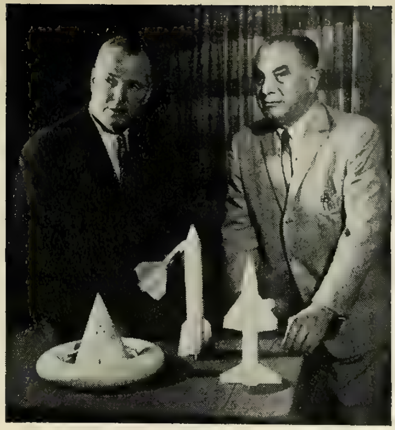

A $14,000,000 R & D Center, housing 9 new laboratories, was revealed as core of Republic's $35,000,000 Research and Development Program at recent announcement by Mundy I. Peale, President, and Alexander Kartveli, Vice-President for Research and Development.

....To join Republic Aviation's new $35 million Research and Development Program for spacecraft, missiles and advanced aircraft

In announcing Republic's $35 million research and development program, designed to arrive at major breakthroughs in the aviation industry's transition to astronautics, Mundy I. Peale, President, set the following objectives:

> "...ACCELERATION OF PROJECTS ALREADY UNDER WAY AT REPUBLIC ON LUNAR PROGRAM FOR MANNED SPACE VEHICLES, AND MISSILES TO DESTROY ORBITING WEAPONS, AND INITIATION OF INVESTIGATIONS LEADING TO NEW CONCEPTS FOR INTERPLANETARY TRAVEL."
>
> "...RADICAL NEW FAMILIES OF LONG-RANGE AIR-TO-AIR MISSILES AND AIR-TO-SURFACE BALLISTIC MISSILES FOR STRATEGIC AND TACTICAL AIRCRAFT."
>
> "...VERTICAL TAKE-OFF FIGHTER-BOMBERS, HIGH-MACH FIGHTER-BOMBERS, AND SUPERSONIC TRANSPORTS."

Alexander Kartveli, Vice-President for Research and Development, emphasized that Republic's program "will not duplicate in any way investigatory work currently in progress elsewhere, but will stress novel concepts and new approaches to basic problems of missiles and space technology."

The program includes construction of a $14 million R & D center to house 9 new laboratories, and anticipates doubling the present research staff.

Senior men interested in the new possibilities created by a simultaneous exploration of all aspects of Flight Technology are invited to study the functions of the new laboratories for more detailed information:

SPACE ENVIRONMENTAL DEVELOPMENT LABORATORY
To simulate space flight conditions and test missile, satellite and spacecraft systems and components; investigate human engineering problems.

RE-ENTRY SIMULATION & AERODYNAMIC LABORATORY
To study hypersonic shock dynamics, real gas effects, heat transfer phenomena and magnetohydrodynamics.

MATERIALS DEVELOPMENT LABORATORY
Study effects of high velocity, temperature, and space environment on materials for spacecraft, missiles and advanced weapons.

GUIDANCE & CONTROL SYSTEM DEVELOPMENT LABORATORY
To develop and test guidance and control systems for spacecraft, missiles and aircraft.

ELECTRONICS DEVELOPMENT LABORATORY
Study and explore all problems connected with highly specialized, complex electronic systems required for advanced forms of spacecraft, missiles and aircraft.

ADVANCED FLUID SYSTEMS DEVELOPMENT LABORATORY
To develop and test fluid power systems for spacecraft and missiles capable of operation under extremely high temperature, high pressure conditions.

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A. Kartveli, Vice President, Research and Development

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AERO-THERMODYNAMICISTS EXPLORE HIGH-SPEED RE-ENTRY

A report to Engineers and Scientists from Lockheed Missile Systems – where expanding missile programs insure more promising careers

Advanced weapon system technology has brought to the forefront problem areas requiring attention to interaction between aerodynamic and thermodynamic phenomena. Typical of these is the problem of high-speed atmospheric re-entry.

Expanding research and development activities have coincided with acceleration on top priority programs like our Polaris IRBM. At the same time, positions for qualified engineers and scientists have opened up that are unequalled in responsibility or in opportunities for moving ahead.

Positions in **aero-thermodynamics** include such areas as: aerodynamic characteristics of missiles at high Mach numbers; missile and weapon system design analysis; boundary layer and heat transfer analyses in hypersonic flow fields; and calculation of transient structural and equipment temperatures resulting from aerodynamic heating and radiation.

In addition, openings exist at all levels in **Gas Dynamics, Structures, Propulsion, Test Planning and Analysis, Test Operations, Information Processing, Electronics,** and **Systems Integration.** For these and other positions, qualified engineers and scientists are invited to write Research and Development Staff, Dept. 2911, 962 W. El Camino Real, Sunnyvale, California.

Lockheed / **MISSILE SYSTEMS DIVISION**

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, VANDENBERG AFB, CALIFORNIA
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Maurice Tucker, Aero-Thermodynamics Department Manager, right, discusses combined aero-thermodynamic re-entry body tests being conducted in Division's new "hot-shot" wind tunnel. Others are Dr. Jerome L. Fox, Assistant Department Manager, Thermodynamics, left, and Robert L. Nelson, Assistant Department Manager, Aerodynamics.

THEORETICAL maximum performance of zinc-silver batteries like this is about 176 watt-hours per pound.

duced to a considerable degree before long.

A second problem in the development of nuclear devices is the high expense and low availability of pure isotopes. Also on the list is the development of power conversion equipment for systems not using direct conversion of nuclear energy.

Telemetering

Bureau of Standards Tests Transducers

Because telemetering of flight data is often limited by lack of information on the performance of the telemetering transducers, the National Bureau of Standards (NBS) is extensively investigating these important measuring links.

The program, carried on by NBS for all services calls for development of test methods which can be applied to the selection, application, and improvement of transducers.

Several important findings, including data on the inherent characteristics of the principal types of transducers and a clearer understanding of the requirements for various applications, have already resulted from the program.

Main elements of the program so far have been studies to predict transducer performance under the environmental conditions encountered in flight and the calibration of transducers in terms of their dynamic response. The environmental conditions imposed on the units under study are the usual ones of temperature, shock, pressure, vibration, acceleration; extremes of humidity, pressure shock, or acoustic vibration.

In the studies of dynamic response, the Bureau is especially interested in pressure and acceleration measurements since, in missile testing, more measure-

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ments are made of pressure than of any other quantity. One serious limitation on the use of transducers in this area has been lack of information of the dynamic performance of transducers.

In the work at NBS, a shock tube—designed and built for this purpose by R. O. Smith and P. S. Lederer—is being used. The tube provides a pressure step-function of known value, which can be applied to the transducer pressure gage under study. Gage response is then displayed on an oscilloscope and photographed for futher analysis.

The shock tube is used because it is most effective in generating step-function pressure changes of known amplitude. It is constructed of flanged steel sections, has a cross-sectional area of 3 sq. in., a variable length compression chamber (from 3.4 to 12 feet) and an expansion chamber 8 feet long.

The tube has three pairs of optical glass windows, each pair provided with a schlieren system and photomultiplier tube to give a pulse when the shock wave passes. Possible pressure steps last 4 to 5 msec with a step rise time of less than 10^{-8} sec.

Pressures in the compression chamber range up to 1000 psi and expansion chamber pressures reach 350 psi. By using air on both sides of the diaphragm, shock step heights up to 600 psi are generated. The use of helium instead of air in the compression chamber allows the shock step heights to reach 1000 psi. Amplitude of the step is determined from the measured value of the initial expansion chamber pressure and the shock wave velocity.

In the studies of transducers used as accelerometers, one method is to rotate the accelerometer in the earth's gravitational field and another uses a specially designed dual centrifuge. Calibration of acceleration transducers does not present problems at frequencies from 10 to several hundred cps, but when the frequency of interest lies below this, satisfactory test equipment has not been available.

In the dual centrifuge, a known frequency is introduced to the accelerometer under test and the resulting response curve presents a convenient way to read the dynamic characteristics of the unit. The dual centrifuge is a rotating table carrying a second smaller spinning table which the accelerometer is fastened.

The tables are rotated in a horizontal plane at a speed where the transducer under test is carried around a circular path without rotation.

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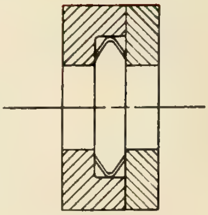

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space age

by Norman L. Baker

First *Sentry* shot near—Preparations for what may be the first reconnaissance satellite launching attempt are now being finalized. The first launch may be undertaken at Cape Canaveral in December or January, instead of Vandenberg AFB as originally planned, using an *Atlas* booster instead of a *Thor*. One of the *Atlas* gantrys at Cape Canaveral is being modified and extended to facilitate working space for the added upper stages.

Satellite's payload is reported to be a 250-lb. test prototype of the large (1000 to 1500-lb.) version to be launched later. Direction of launch is expected to follow the northeast flight path of the last two *Explorers* in order to sweep a near-maximum area of the earth's surface.

Bell leading *Dynasoar* contender?—The Space Flight and Missiles Division of Bell Aircraft is favored to win a large slice of the *Dynasoar* space system whatever the outcome on prime contractor selection. The Bell and Boeing designs for the piloted final stage of the system are similar in configuration and power output. For example, early designs of both systems called for a flat underside for optimum glide characteristics and heat dissipation.

Although all vehicle designs are far from the selection stage, two boost systems are under consideration. One would use an extensively modified *Navaho*-type system and the other would use the first stage of the *Titan* ICBM. Bell early pioneered the rocket glide bomber concept in this country through the efforts of Dr. Walter Dornberger, military leader of the A-9/A-10 project for bombing New York City during World War II. Dornberger tried to sell the concept then known as BOMI, to the Air Force some five years ago. Another notable boost-glide study was General Electric's C-3 program, a joint operation with Republic, which is now all but forgotten.

Rocketdyne to be dropped from X-15?—An upswing in development progress of the XLR-99 *Pioneer* rocket engine at Reaction apparently has convinced the Air Force that Rocketdyne, the back-up engine contractor for the X-15, could be dropped from the program. Reaction, bogged down earlier in the year for lack of hardware support, has been able to regain a lot of lost ground with delivery expected in time for first powered flight.

The National Aeronautics and Space Administration's budget is expected to jump considerably during the next fiscal year as more money is needed to carry for the "exploration of science and space at high priority." NASA currently has about $301 million available for fiscal year 1959, with close to $250 million of this being devoted to space activity and facilities construction. Many observers feel that $1 billion will be made available to the space administration as annual working capital by 1960.

What's new in TITANIUM pricing:

Recent price reductions in titanium metal—the seventh initiated by Titanium Metals Corporation of America since 1954—have provoked renewed interest in the design properties of the material.

With prices down 45 percent from levels four years ago, and weight, heat, and corrosion problems severely increased in aircraft and missiles now being devised, titanium metal's role is growing ever more important.

The purchasing of titanium can sometimes be a complex task. TMCA hopes it can help you in that task by passing along some reminders on methods to save money on the "price extras" that apply to all orders of titanium metal. Of course, design considerations are paramount, but sometimes slight changes that can be tolerated by engineering can mean large cash savings.

* QUANTITY

Production costs decrease as the amount of material being processed increases. Therefore, quantity schedules have been established to pass along economies to the purchaser. A customer can often benefit by careful consideration of the amount of material he is ordering, compared to the quantity schedule as outlined in TMCA's Buyer's Guide. In many cases, because of applicable quantity extras, upwards of 1,000 pounds of titanium metal are available at no charge to the purchaser. For example, a 10,000 pound shipment of heat-treatable forging billet can cost exactly the same as a 9,074 pound order; a 5,000 pound shipment of plate can cost exactly the amount of a 4,802 pound order. TMCA's district sales managers are always willing to help you take advantage of the price breaks.

* PATTERN SIZES

Although ordering by pattern sizes is an established procedure with more common engineering materials, it isn't always the most economical method with titanium. For example, when small parts are to be cut from sheet, ordering "random size" will save you 75 cents per pound of material. The price allowance is applicable when *specific sheet sizes are ordered,* but shipment is permitted in widths ranging from −6″ to +2″ and lengths ranging from −18″ to +12″. Weight of random size sheets and exact size sheets of the same gage can be combined when computing quantity prices for a given order.

* TOLERANCE

Here important weight saving advantages are accorded designers and cost savings accrue to purchasing. Material specified ½ AISI tolerance weighs 10% less than standard-tolerance material.

TMCA's district sales manager will be happy to provide you information on grades and products where this tolerance schedule applies.

* WIDTH

If you determine the end use of metal before ordering, you will sometimes realize important cash savings. For example, titanium metal 24″ wide is classified as "sheet," and sheet prices apply. However, by ordering material ¹⁄₁₆″ less in width, strip prices apply at a savings of 50 cents to $1.00 per pound.

* THICKNESS

A more substantial saving is possible in specifying plate rather than sheet where the substitution meets design requirements. Metal 0.187″ thick is priced as sheet. However, metal 0.1875″ is priced as plate at a savings of $2.10 per pound.

* SIZE

A size extra of 20 cents per pound applies to billets 8″ or less in diameter. However, billets 8¹⁄₁₆″ in diameter are supplied at base price. If the additional ¹⁄₁₆″ can be tolerated by design, the financial savings on material can be realized.

These are just a few examples of the money savings possible through careful study of the "price extra" sections of your Buyer's Guide.

Fixed, published schedules are vital in guaranteeing standard quotations to all customers in highly competitive work. By the same token, TMCA customers will receive every pricing benefit possible under these schedules.

* * * * * *

If you are placing an order for titanium, or considering purchase of titanium, contact the TMCA sales manager in your district. He can help save you money and time.

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Axial Flow Ram Jet Has Rocket Application

An axial flow ram jet development by Strato-Missiles, Inc., New York, may mean a technological advance in missile propulsion.

The patent application for the system is classified. However, the jet reportedly can be adapted for use as an anti-missile missile, a surface-to-air missile, or short range surface-to-surface missile. The basic elements, according to the company, can be incorporated in any diameter or length of missile configuration. The company calculates that a 15-inch diameter missile will have an initial acceleration of 2,300 feet per second, or 1,800 miles per hour.

Strato-Missiles said the system is much cheaper to manufacture than the conventional type of airplane jet engine. Peak variations in the combustion chamber reportedly amount to only 5% of the minimum combustion chamber pressure.

The system centers around the development of a differently designed turbine. The turbine is bladeless, therefore there are no buckets to lose nor a need for stator blades. Because of the absence of any blades, the inlet gas temperature can be very high without the fear of blade cracking or aging. There is no creep or interference, and the speed of the turbine is limitless.

If used in a missile, launching could be accomplished with almost no preparation and in a very short time, the company said.

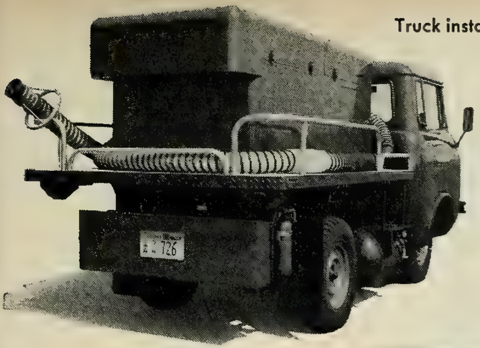
Operational data has been accumulated involving tests conducted with various sized turbines. An 18″ diameter turbine, 3½″ wide, spinning at 9,000 RPM, has produced 300 horsepower with an inlet pressure of 135 psi (steam) freely exhausting to atmosphere. With a vacuum exhaust, the horsepower could almost be doubled. A 9¾″ diameter turbine, 2″ wide, spinning at 16,000 RPM, has produced 110 horsepower.

Strato-Missiles is completing a prototype test turbine.

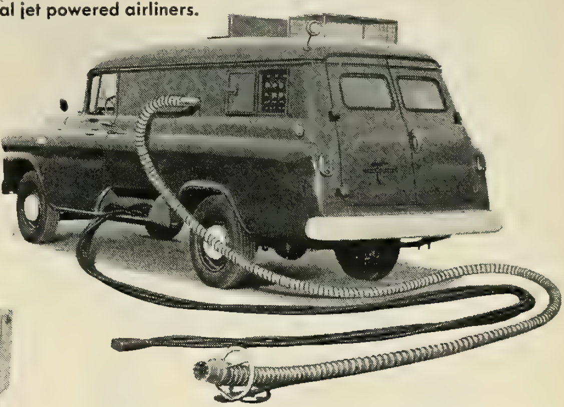
Top Scientists To Meet On Space-Medical Topics

Many of the nation's top space scientists are scheduled to speak at the three-day meeting of the second International Symposium on the Physics and Medicine of the Atmosphere and Space.

The San Antonio meeting, which will run from November 10-12, will be attended by more than 600 scientists and physicians working in the space field. Chairing the opening session will be Dr. Hugh L. Dryden of NASA.

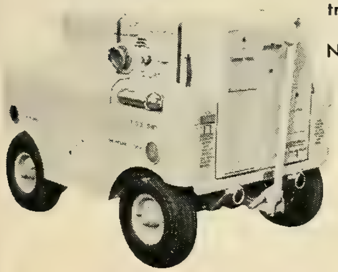


Truck installations supply pneumatic power for main engine starting, cooling and heating, electrical power for commercial jet powered airliners.

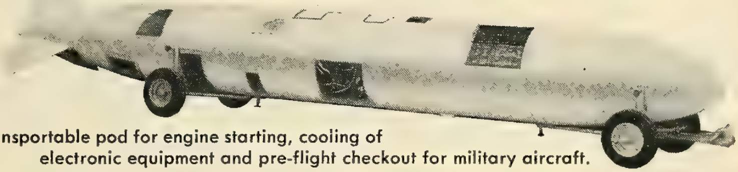


Dual carts for main engine starting, air conditioning and electrical power for military aircraft.

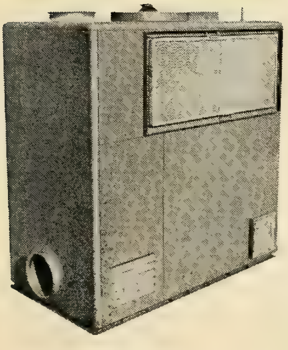
Reliable and versatile ground support



AiResearch MA-1A trailer for starting military aircraft. Nearly 2,500 in the field.



Air transportable pod for engine starting, cooling of electronic equipment and pre-flight checkout for military aircraft.



Lightweight Freon system, usually installed in a van or trailer, for cooling electronic equipment in support of missiles.

AiResearch Aviation Service Company ground support equipment is tailored to meet turbine powered aircraft and tactical missile requirements. Lightweight, compact units can be designed to specific configurations or installed on standard vehicles.

Heart of the lightweight ground support systems are AiResearch gas turbine compressor power units. Capable of delivering both electrical and pneumatic power, nearly 8,000 of these units are operating successfully and dependably in the field.

Support services can include: main engine starting, pressurization and air conditioning of cabins and compartments, missile pre-flight check-out, removal of snow and ice from aircraft and equipment, supply of DC or AC electrical power at any required frequency, and low pressure, high flow air for operation of a variety of actuation systems. The units have push button starting and operate without delay under all weather conditions.

The Garrett Corporation, through its AiResearch divisions, is the world's largest producer of lightweight turbomachinery. The AiResearch Aviation Service Company can package both AiResearch equipment as well as that of other manufacturers to meet your individual ground support requirements. Your inquiries are invited.

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Soviets Cite Progress In Controlled Satellites

The Soviet Union has claimed the solution of various problems in the task of establishing oriented satellites and automatic satellites. According to Radio Moscow, Prof. Dobronravov, a Soviet astrophysicist, has stated that: "Technical and industrial possibilities for the construction of an automatically-controlled satellite capable of speeds of 6.85 miles per second now exist in the USSR." Indications were that this vehicle would be in a moon-earth orbit.

Dobronravov also stated that the necessary equipment for one or two men to take a cosmic trip for ten days could be placed in a vehicle with a weight equal to *Sputnik* III. The Soviet scientist noted that "the achievements of Soviet science, technology, and industry allow the prediction that the trip to the moon will be possible in the near future."

There were no details given with the statements.

There was also strong indication in the Soviet press that work is well underway on a fully-oriented satellite. An automatically-oriented magnetometer was installed in *Sputnik* III, as well as two other measuring transducers which made it possible to determine the satellite's position relative to the Earth's magnetic field and the speed of the satellite's rotation about its own axis.

There was evidence that the Soviet stabilizing system will combine gyroscopes and vernier jets.

SBA Wants Liaison At Contractor's Plants

The Small Business Administration has recommended to the Senate Small Business Committee that SBA liaison officials supplement military representatives at defense plants.

The recommendation was carried in an SBA report to the Senate group and termed the Defense Department system "ineffective." The report was sharply critical of DOD efforts to get small business a larger share of the budget dollar.

Under a Pentagon directive (ASPR 1-707.4), a military representative is supposed to be assigned to plants to determine the "adequacy of the subcontracting program as well as its deficiencies and direct the necessary steps for improvement to be taken." The SBA report said this surveillance was found ineffective and in some instances wholly missing.

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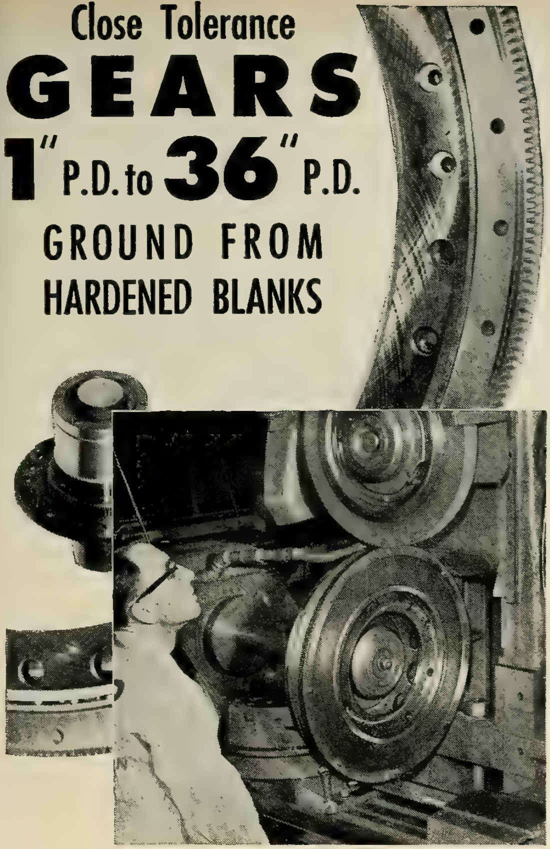

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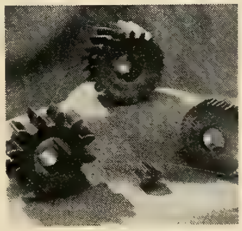

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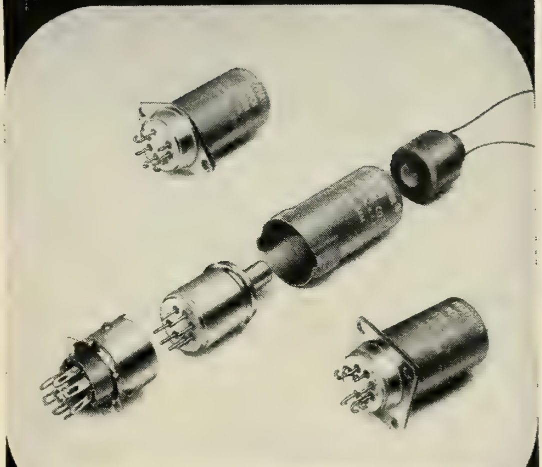

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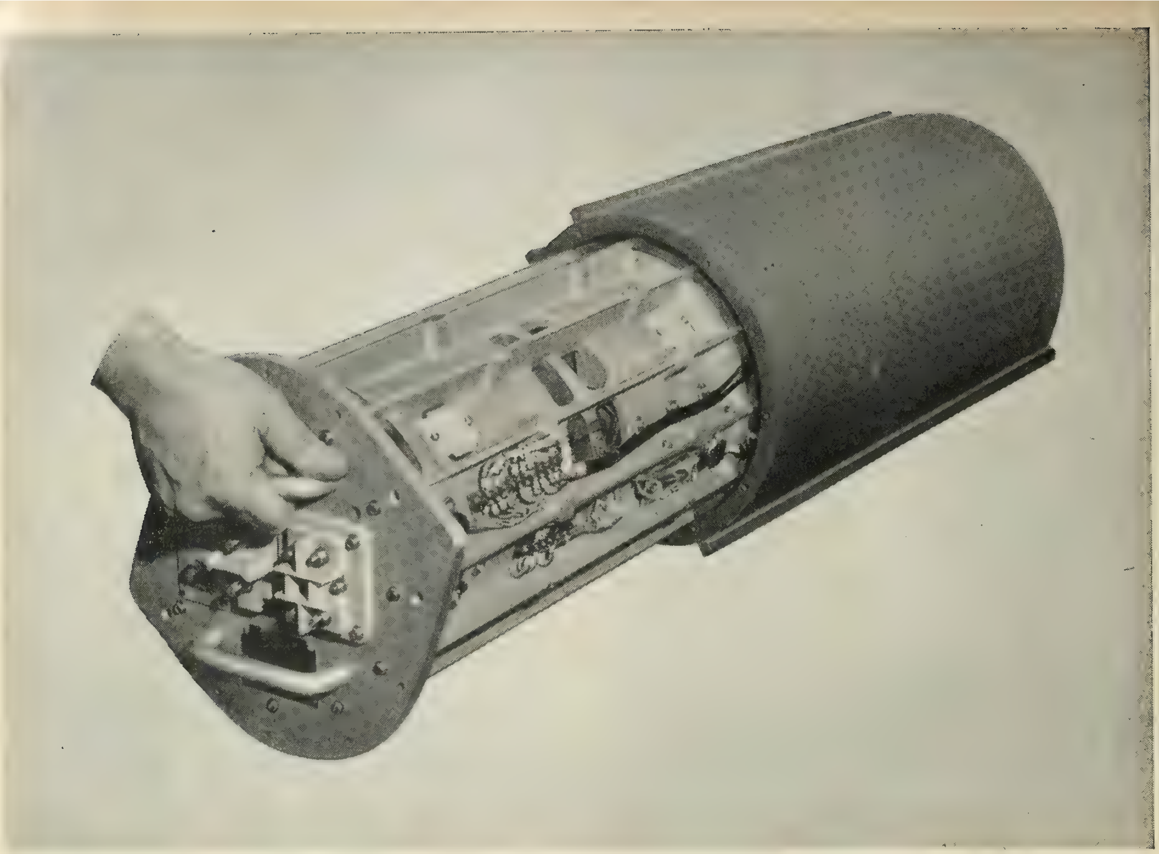

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Bendix Canistered Inverters, environment-free and completely sealed, are now in production for the Atlas and Thor missiles. Designed for dependable and efficient operation, Bendix Canistered Inverters are completely sealed against the effects of altitude and can withstand conditions from sea level to outer space.

Cooling techniques employed enable these units to provide full-rated output throughout the flight without external cooling. Both voltage and frequency regulation are accomplished by static, magnetic amplifier-type regulators. Since these regulators have no moving parts, output voltage and frequency are not affected by vibration and shock. The total harmonic content of the output voltage per phase is less than 5%.

Bendix Canistered Inverters are the product of years of development and experience in manufacturing electrical power equipment for aircraft and missiles. They are engineered to meet the strenuous requirements in performance and reliability called for in today's (and tomorrow's) missiles. For more detailed information write to RED BANK DIVISION OF BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY.

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astrionics

by Raymond M. Nolan

Despite all the furore about BMEWS and other long-range radar, don't discount other means of missile detection. Many companies are using their own funds in a gamble that effective missile detection will only come from geomagnetic phenomema. One company spokesman said that the frequencies employed will be high audio—which brings the electronics picture full 'round from the currently employed KMC frequencies. The method will reportedly sense disturbances in the ionosphere and will have the dual advantage of being passive and will operate over the horizon at the speed of light.

Soviet activity around the South Pole has caused some concern to a firm retained by the Army to look ahead in the ECM field. Main reason for the disturbance—think how easy it would be to traverse a sensor from Cape Canaveral to Vandenberg Air Force Base if you were sitting on the bottom of the world and distance was no problem.

At the recent Association of the U.S. Army meet in Washington, AC Spark Plug had a color picture (but not the hardware) of its miniaturized Achiever stable platform. Used in conjunction with transistorized electronics components, the system will probably weigh about half the present one (estimated at 600 pounds). AC spokesmen said that the miniature units were developed "mostly" with their own money. No buyer has been found yet, but AC people are confident that the lightweight set will provide the answer to "at least" one of the upcoming second generation missiles.

One little-noted fact about the recent lunar probe was that it relayed radio signals between Hawaii and England. Gen. Schreiver reportedly surprised W. W. Kellog, head of the U.S. technical panel for IGY satellites, with his announcement that signals from a transmitter in Hawaii were picked up by the doppler command receiver in the lunar probe, altered somewhat and rebroadcast by the small transmitter in the probe. The signals were then picked up by receivers in Manchester, England and at Cape Canaveral. Signals from Canaveral were also detected at Manchester and Hawaii. Although this was only a test, it was the first time a signal was relayed for such a distance, and it clearly indicates that the many proposals for TV and communications relay satellites are feasible.

A "sun" computer, designed by the Sandia Corporation, is being used for missile tracking. It is said to lessen the loss of projectiles against the bright sun. To operate, trackers set the small computer on a scale map of range, and then position the instrument's base on the specific camera station. If the computer reading shows that the missile will pass between sun and tracking camera at time of shoot, the firing time is changed to one where the condition will not prevail (also shown on the computer).

Another item shown at the AUSA meeting was a "device" recovered with the *Jupiter* nose cone. The so-called "device" was actually the fuzing and arming system for operational nose cones. The unit, developed by Ford Instrument Company and Picatinny Arsenal, is said to operate on inertial principles.

Latest version of the *Falcon* being developed is the GAR 11. Using the Hughes formula of even-numbered GAR's being radar-guided and odd-numbered ones infra-red guided, this means that the latest one is an IR bird. The GAR 11 reportedly has a nuclear warhead. Hughes people are enthused about their latest missile and feel that it will provide the all-weather capability that USAF wants.

NOW . . . A NEW SOURCE FOR
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Hayward Scientific Glass Corporation, Whittier, California, has completed its new research laboratory for melting special glasses in platinum crucibles. The primary purpose of the laboratory will be to develop and produce three types of glasses; those for special and strategic application, such as the rare element types; those seldom manufactured, solely because of normal lack of demand; and glasses normally produced in the United States but momentarily not available in the size and quality of pieces needed or in the rigid refractive index tolerances required.

New formulas may be developed in small melts, yielding 5 to 10 pounds of glass; then large melts can be made to provide production quantities.

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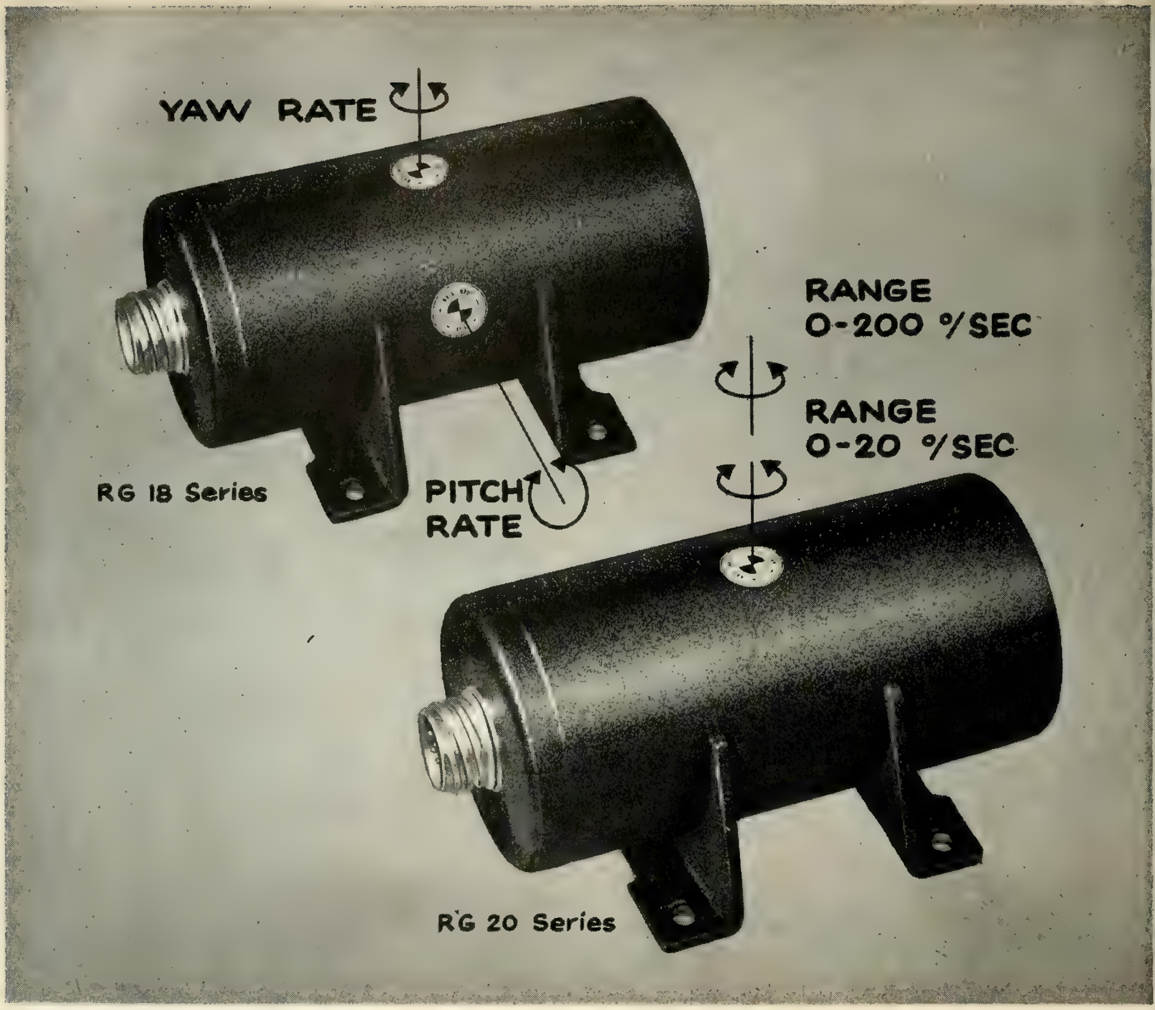

New Humphrey dual-rate gyros do the work of two units

Now important reductions in the space required for instrument and control packages can be made with the introduction of a new Humphrey rate gyro that replaces two ordinary gyros. The new design utilizes a single motor to drive two separate wheels in one unit. With this new development, it is possible to measure rates about two different axes with an RG-18 Series Gyro or cover two different rate ranges about the same axis with a single RG-20 Series instrument.

RG-18 gyros should find widespread use for applications now requiring two instruments. For example, one unit could be used to measure both pitch and yaw. The RG-20 Series, with its two different rate ranges, may be applied to instrumentation systems where greater accuracy is required. For example, a single unit can be furnished to cover the rate ranges from 0—20 degrees/second and from 0—200 degrees/second. In effect, you expand the dynamic range of your instrumentation system from 100 to 1 to 500 to 1. This expanded scale gives you far greater accuracy.

The new rate gyros are built with two independent pickoffs—one for each axis or one for each range. They meet tough environmental conditions, such as temperature from −65°F to 180°F while operating, relative humidity 100%, unlimited altitude and excellent resistance to acceleration, vibration and shock. Phone or write today and let the kind of engineering that developed these new dual-rate gyros go to work for you.

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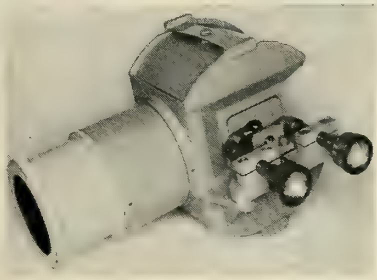
Rotating Mirror, Camera Study Speed Events

Two standard laboratory instruments—rotating mirror and rotating drum cameras—have been developed by **Avco Manufacturing Co.** for studies of radiation, explosive compound development, solid fuel ignition and other applications in the missile field.

Displayed for the first time at the recent ISA instrumentation-automation conference in Philadelphia, the cameras were developed and in use for two years in connection with company research in high-temperature gas dynamics and atmospheric reentry problems involved in the Air Force *Titan* ICBM program.

The rotating mirror camera, says the manufacturer, records position vs time relationships, sweeping the image from a hypersonic object source onto fast emulsion film strips.



Part of the machine is a hexagonal, first surface mirror, rotating at 3,000 rps. The drum camera, in addition to making position-time records, also can be used with a densitometer to produce accurate data of hypervelocity phenomena.

Circle No. 292 on Subscriber Service Card.

Transducer System Checks Lox or Fuel Levels

An airborne servo transducer system has been designed for continuous measurement of LOX or fuel head in missiles, and is now on the market.

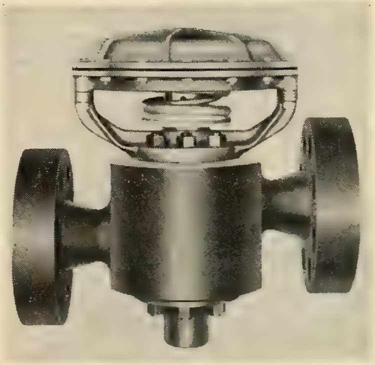
Wallace O. Leonard, Inc. claims that the unit is based on a unique force-balance servo system that makes it possible to measure the height of a column of liquid within very close tolerances. Typical values for a 22-ft. column are given as: repeatability of 0.040 in., hysterisis 0.080 in.

Additionally, because the transducer senses differential pressure between the bottom and top of the tank, normal LOX boiling will not cause bad readings. Called Leonard model 502400-2, the system has two potentiometer outputs, one fine and the other coarse; and optional outputs include code generators, synchros, potentiometers, or combinations of these devices.

Circle No. 289 on Subscriber Service Card.

New Line of Air Valves for Missile Test Stands

Designed to provide fast response and leak-free operation, **Sinclair-Collins'** line of 5,000 psi air control valves is now on the market.



The valves are flange-mounted and diaphragm operated, with aluminum bronze billet or alloy steel bodies, and were developed for use on missile test stands, or other applications requiring precise control of ultra high pressure air.

Sleeve-type construction, employing replaceable hardened stainless seat sleeve insert in the valve body, is said to maintain perfect alignment of valve stem and seats at all times. Stellite-faced stem seats are standard. Complete interchangeability of precision-ground lapped stems and seat sleeves simplifies in-service maintenance.

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Ceramic Resists Extreme Heat-Shock Applications

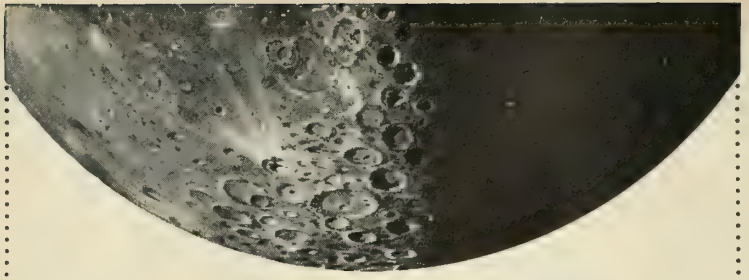
Pressed ceramic parts which the manufacturer says can withstand thermal changes such as those involved in water quenching from 2,200 deg F, are now available in production lots.

Named ThermoShock HT-2 ceramic, the new material is a product of **Duramic Products Inc.,** and is the result

NOTE: *For additional information about any product mentioned in this section of Missiles and Rockets use the attached prepaid reply cards. Circle numbers shown on the reply card that correspond with numbers appearing beneath items described. If no circle number accompanies the article or advertisement, give page number (and advertiser's name) on line provided at bottom of the card.*

Your requests for information will be forwarded promptly to the companies concerned.

The Editor



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TURBINES, PUMPS, COMPRESSORS

Get in on the development of the most advanced high-speed rotary equipment ever built

Here's your opportunity to step up to a new, higher level of turbo-machinery technology—the Large Rocket Engine.

Whatever type of rotating machinery you know best, your experience could be extremely valuable in the important developments now going on at Rocketdyne. The seasoned and ambitious man who has cut his teeth on jet engines, steam or gas turbines, or other elements of rotating machinery, is urgently needed to apply mechanical principles to meet the increasing demands of power plant performance.

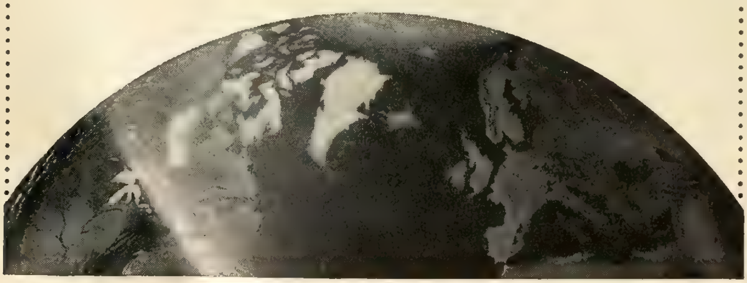
The combination of high speed, light weight, heavy loadings and exceptional pressures required in rocket engine work is leading to an entirely new breed of high-performance rotating machinery...and a new breed of engineer. You can be one of this advance guard of the turbo-machinery field—if you have the desire to build your professional status by accepting new challenges.

Rocketdyne is building high-thrust rocket engines for the nation's major missiles. You'll work with the leading producer in the nation's fastest growing industry. You and your work will be recognized as a vital part of the overall achievements. Testing facilities are among the world's finest. The power produced is beyond anything ever before thought possible. If you would like to tackle new assignments working alongside some of the finest minds in turbo-engineering, write and tell us about your background: Mr. D. L. Jamieson, Rocketdyne Engineering Personnel, 6633 Canoga Avenue, Canoga Park, California.

ROCKETDYNE

A DIVISION OF NORTH AMERICAN AVIATION, INC.

BUILDERS OF POWER FOR OUTER SPACE



Circle No. 22 on Subscriber Service Card.

of a two-year development program by the company's engineers. Key to the ability to withstand extremely rapid temperature changes is ThermoShock's zero thermal expansion over a 2,400 deg F temperature range.

Applications include copper brazing locators; projection and spot welding jigs, shielded arc welding jigs.

Circle No. 285 on Subscriber Service Card.

Rocket Thrust Controller Senses Small Errors

Capable of sensing and correcting small errors in thrust chamber pressure in liquid propellant rocket engines is the claim of a new hydromechanical controller now on the market.

The controller corrects errors by producing a rate of change in the actuator position.

The actuator, an integral part of the control, can be used to govern the flow of propellent to a gas generator by the flow of hot gas from the generator to the turbine, thus controlling the turbine speed and propellent flow to the main rocket trust chamber, according to **Bendix Products Division.**

A two-stage pressure regulator obtains accurate reference, a high-gain pressure error sensing diaphragm and a two-stage hydraulic amplifier comprise major portions of the system. Accuracy and load insensitivity are obtained by well-known servomechanism techniques, such as degenerative actuator velocity feedback.

Circle No. 290 on Subscriber Service Card.

Gasket and Seal Material Withstands Fluid Attack

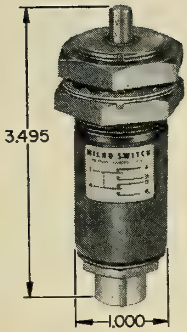
A Teflon-felt material, said to consist of pure Teflon fibers impregnated with a Teflon resin, is claimed to have a wide temperature range, and to be usable continuously from below minus 100 deg F to plus 400 deg F. Under certain conditions, according to **General Plastics Corp.,** the material has been used up to 600 deg F.

The manufacturer claims that, since the felt is all Teflon, it will withstand attack by strong acids and bases, and is unaffected by water or any common

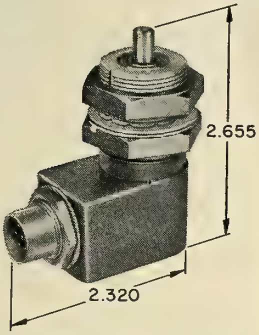
MICRO SWITCH Precision Switches

Four switches to meet special conditions in airborne and missile launcher applications

These four special switches are alike in that all are sealed in enclosures filled with inert gas under pressure. Also, in each switch a scraper ring on the actuator shaft prevents jamming or binding even in ice or mud. And all are manufactured with the utmost care and precision.



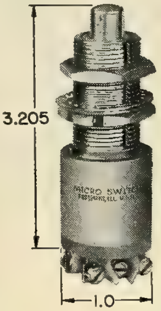
1EN75R
Has plunger actuator; miniature Deutsch receptacle at bottom.



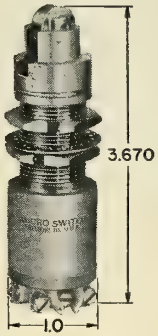
1EN76R
Has plunger actuator; miniature Deutsch receptacle at side.

These new switches withstand high shock . . . meet requirements of MIL-S-901B

Shock resistant. Meet requirements of MIL-S-901B. Each switch contains two "SM" SPDT basic switches. Operating force 6-12 lbs., release force 4 lbs.; overtravel .250 in. Rating: 28 vdc, 24 amps. inrush; 4 amps. resistive; 3 amps. inductive; 115 vac, 5 amps. Ask for Data Sheet 152.



12HR1-S
Plunger actuator

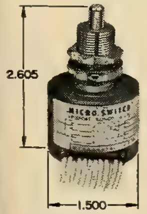


22HR1-S
Roller plunger actuator

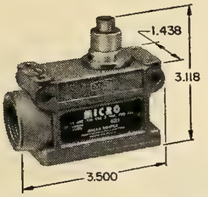
These switches operate dependably at temperatures up to 600° F.

Hermetically sealed, high temperature DPDT switches for reliable operation to 600° F. Metal-to-metal and glass-to-metal seals in accordance with MIL-E-5272A. Operating force 6-12 lbs.; release force 5 lbs.; overtravel .250 in. Rating: 28 vdc, 5 amps. resistive; 2 amps. inductive. Ask for Data Sheet 122.

Other MICRO SWITCH Precision Switches for aircraft, missile, rocket, and launcher applications include these . . .



A 4-pole DT assembly with four SPDT "SM" basic switches sealed in enclosure only 1½" diameter.



Rugged limit switch for missile shelter, erecting, and launching equipment. SPDT.

Versatile sealed limit switch for launching equipment. Head, arm, and operating direction adjustable. Two-circuit basic switch.

Your request for data sheets covering the switches described above or for information about the switches shown at left will receive prompt action.

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls, Ltd., Toronto 17, Ontario

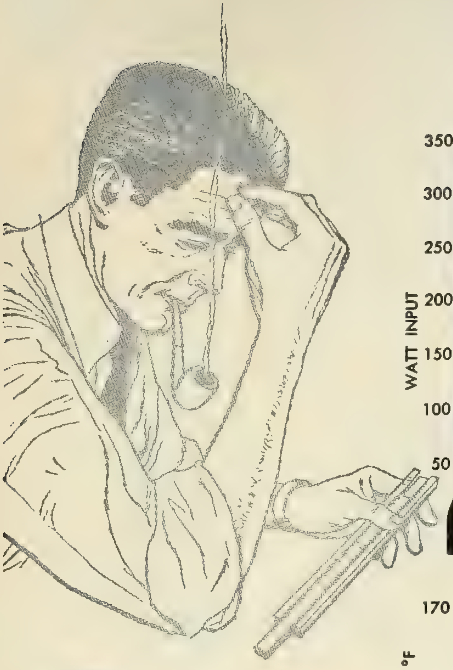
Look in the Yellow Pages for the name of the branch office and sales engineer nearest you.

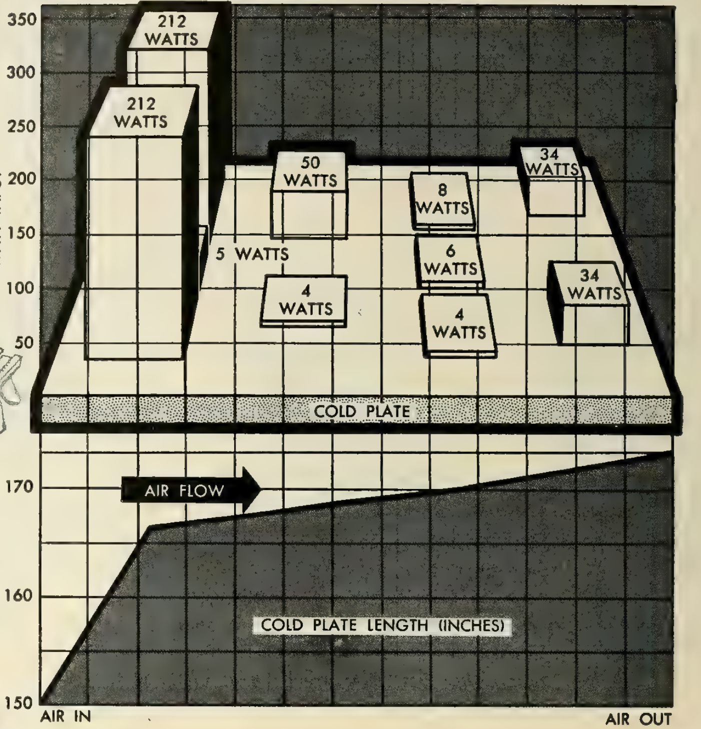
HONEYWELL
Honeywell
MICRO SWITCH PRECISION SWITCHES

Circle No. 53 on Subscriber Service Card.

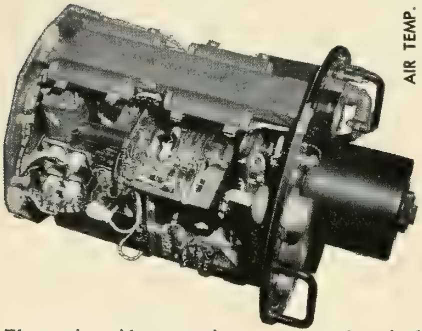
ELECTRONIC COOLING

Requirement: Stay within customer's envelope. Dissipate 569 watts thru 13 x 10 in. cold plate and not exceed a plate temperature of 173°F with cold plate air-in temperature of 150°F. Provide areas for circuits to be mounted to cold plate surface between power units.

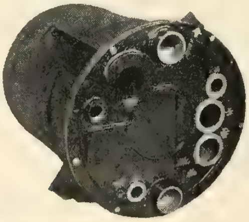




Answer: UAP cold plate configuration designed to provide adequate heat transfer from localized high, medium and low heat concentration areas with air-in temperature at 150°F. All requirements met with room to spare.



Electronic guidance equipment mounted to *both* sides of UAP cold plate, contained in UAP pressurized case . . . for control of air-to-air missile.



The hypothetical conditions as stated above are typical of the problems that have come to us since the advent of electronically controlled supersonic missions.

UAP eminence in the heat exchanger field has been firmly established over the years by delivery of systems and components of proved optimum performance and reliability. Our experience covers the engineering and production of devices for application as cold plates, gas-air heat exchangers, air-liquid heat exchangers, and associated controls; mechanical refrigeration systems and expendable refrigeration systems. These can function in the anticipated environmental conditions and utilize one or more of the following heat sinks; ambient air, expanded bleed air, expanded ram air, ram air, expendable refrigerant, or available liquid.

Make your requirements our responsibility. Call . . .

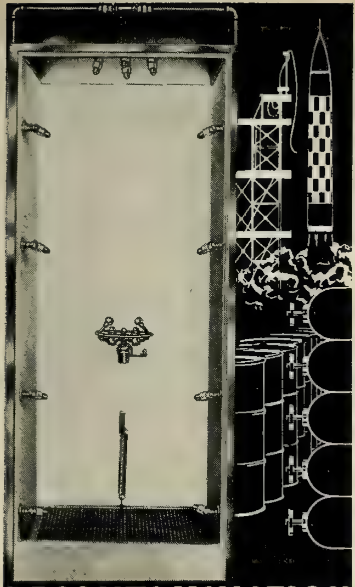
CALIFORNIA.............................1101 Chestnut St., Burbank, Calif., VI 9-4236
NEW YORK...........................50 E. 42nd St., New York 17, N.Y., MU 7-1283
OHIO...................................1116 Bolander Ave., Dayton, Ohio, BA 4-3841
CANADA....................United Aircraft Products, Ltd., 5257 Queen Mary Road, Montreal, Canada, Elwood 4131

UAP UNITED AIRCRAFT PRODUCTS INC.®

a famous family of aircraft essentials since 1929

UNITED AIRCRAFT PRODUCTS, INC.

1116 BOLANDER AVENUE, DAYTON, OHIO



DECONTAMINATION BOOTH

Instantly ready for vital FIRST AID

HAWS

Miscues and accidental exposure to dangerous propellants and other chemicals can occur with shocking suddenness. Adequate water irrigation is an important key to minimizing such injuries and subsequent claims. HAWS Decontamination Booth is the answer... a complete safety station for immediate first aid.

HAWS MODEL 8600
DECONTAMINATION BOOTH

is made of durable, lightweight reinforced fiberglass plastic, and features Haws Eye-Face Wash Fountain, eight lateral body sprays and overhead spray unit. **All are simultaneously activated by weight on the base-mounted foot treadle!** Contaminated victims are instantly "covered" with water that floats away foreign matter from body and clothing.

At aeronautical and astronautical installations everywhere, HAWS Safety Facilities are important in boosting air-age safety programs. Find out what this equipment can mean to **your** operation. Full details sent on request, with no obligation.

HAWS DRINKING FAUCET CO.
1443 FOURTH ST. • BERKELEY 10 • CALIFORNIA

EXPORT DEPARTMENT • 19 COLUMBUS STREET
SAN FRANCISCO 11, CALIFORNIA

Circle No. 23 on Subscriber Service Card.

fuels, lubricants, hydraulic fluids or solvents. Since most materials do not adhere to Teflon, cleaning for re-use is said to be simple.

Gaskets and seals exposed to severe corrosion and elevated temperatures are among the uses forseen for the new material.

Circle No. 288 on Subscriber Service Card.

Ground-based Theodolite Checks Missile Alignment

Now designed and in the process of being fabricated is an optical azimuth alignment electrotheodolite, primarily for use with the *Thor* missile program. The instrument is being built under a $1.7 million subcontract, let by AC Spark Plug to the **Davidson Manufacturing Co.**

The ground-based electrotheodolite is said to be a precision optical device, designed to monitor the azimuth alignment of the missile during pre-launch.

Circle No. 297 on Subscriber Service Card.

Subminiature Amplifier Provides Variable Gain

An AC instrument amplifier, Model 2618, is said to satisfy requirements of missile telemetry, is completely sealed, and will operate continuously in ambients of 250 deg. F.

Endevco Corp. says the amplifier is designed specifically for application with company-made piezoelectric accelerometers, with variable gain of 6 to 20. The unit is completely sealed. Fully compensating feedback is said to reduce harmonic distortion and nonlinearity to less than 1%, with a gain stability of plus or minus 1%.

Circle No. 296 on Subscriber Service Card.

Regulator Diodes Give Circuit Flexibiltiy

Silicon Zener Regulator Diodes that are said to contribute to maximum circuit flexibility are now available from **Motorola's Semiconductor Division.**

Manufactured in both 10 and 50 watt power ratings, with voltage ranges up to 200 volts, the diodes come in several series. The 10MZ series is rated for 10 watts at 55 deg. C, is housed in Jetec, a standard 10-32-stud package. The 50MZ series is housed in the TO-3 package, with either plug-in or solder-in features, as well as series interlock construction for protection against overvoltage on load. Both series are available with either anode or cathode connected to the case.

Circle No. 295 on Subscriber Service Card.

FOR THE NAVY'S POLARIS
ALLOY STEELS
FOR HIGH
STRENGTH

(Official U.S. Navy Photograph)

Our metallurgists and engineers will be glad to work with your personnel in developing the most advantageous use of Republic Stainless Steels, Alloy Steels, and Titanium. There's no obligation. Write Republic Steel, Dept. MR-6155B, 1441 Republic Building, Cleveland 1, Ohio

World's Largest Producer of Missile Metals—Titanium, Stainless Steel, and Alloy Steel

REPUBLIC STEEL

Circle No. 24 on Subscriber Service Card.

contract awards

LAST MINUTE AWARDS

CDC Control Services, Inc., automatic control systems specialists of Hatboro, Pa., was recently awarded two contracts of unspecified amounts. The first of the contracts calls for a transonic cascade tunnel control system for the division's Flight Propulsion Laboratory. The second requires CDC to furnish a complete surge control system for five test facility compressors.

A $1-million prime production contract has been awarded to **United Electrodynamics** of Pasadena, Ballastics Missile Center, following an earlier contract under which United designed and developed a transistorized telemetry system for the Air Force *Atlas, Titan* and *Thor* Ballistic Missile Programs.

From Boeing Airplane Company—**Telecomputing Corporation,** Los Angeles, has received $115,000 for production of floated rate gyros for the Air Force *Bomarc* missile.

From Army—**Chrysler Corp.,** Detroit, received a $2.1-million contract for the *Jupiter* missile program.

By Guided Missile Division, Chrysler Corp.—A contract with an estimated value of $450,000 has been awarded **Allen B. Du Mont Lab., Inc.**

AIR FORCE

By the National Institute of Health of the U.S. Department of Health, Education and Welfare.

RIAS, a basic research institute supported by the **Martin Co.,** has been awarded grants for two research programs. One, a grant award of $14,160, covers a project to study the "Composition and Metabolism of Chloroplasts." The second is a grant award of $20,540 for a study of the Mechanism of Photosynthetic Reduction of carbon monoxide.

By Headqr., Ogden Air Materiel Area, U.S. Air Force, Hill Air Force Base, Utah:

Boeing Airplane Co., Pilotless Aircraft Div., Seattle, Wash., received $192,360 for technical data for IM-99A missile.

By Patrick AFB, ARDC, U. S. Air Force, Patrick AFB, Fla.:

Westvaco Chlor-Alkali Div. of **Food Machinery** received $37,240 for rocket propellant.

National Co. Inc., Malden, Mass., received $50,000 for standards primary frequency.

By Headquarters, Air Force Flight Test Center, ARDC, Edwards Air Force base, Calif.:

Space Corp., Garland, Tex., received $36,271 for installation of blast instrumentation system.

Electronic Engineering Co., Santa Ana, Calif., received $35,808 for addition of second airborne telemetry monitoring system.

By HQ Cmdr. AMC, Wright-Patterson AFB, Ohio.:

Airborne Instruments Laboratory, Cutler-Hammer, Inc., Mineola, N.Y., received $1 million for composite program of study, planning and recommendation for the electronic reconnaissance system.

Lear, Inc., Grand Rapids, Mich., received $48,720 for indicators, attitude, settable pitch, Model A and B for service test on X-15.

Marquardt Aircraft Co., Van Nuys, Calif., received $1,443,737 for qualification tooling for RJ43-Ma-3 ramjet engine in support of *Bomarc* missile program.

By Headquarters, Warner Robins Air Materiel Area, USAF, Robins Air Force Base, Ga.:

Goodyear Aircraft Corp., Akron, Ohio, received $444,936 for repair/modification of TMO76A weapon system.

ARMY

By Procurement Office, Aberdeen Proving Ground, Md.:

Ampex Corp., Silver Springs, Md., received $67,638 for recording equipment for ARPA satellite tracking complex.

By Headquarters, Redstone Arsenal, U.S. Army Ordnance Missile Command, Redstone Arsenal, Ala.:

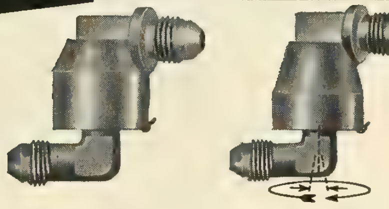
Wall Tube & Metals Co., received $28,235 for two items of stainless steel tubing, type 304 round, seamless.

Thiokol Chemical Corp., Trenton, N.J., received $240,017 for continued development of XM20 and XM30 rocket engines.

By Boston Ordnance District, Boston, Mass.:

Raytheon Mfg. Co., Andover, Mass.,

NOW AIRCRAFT TYPE SWIVEL JOINTS



LOW TORQUE PLANE SWIVEL JOINT—
360° rotation in a single fixed plane.

NEW SELF-ALIGNING SWIVEL JOINT—
360° rotation *plus* 15° side flexibility.

BARCO Offers Two Standard Types

Here are the newest designs in the field! SEND TODAY FOR BARCO CATALOG 269A. Since 1941 Barco Swivel Joints and special Flexible Assemblies have met the precise requirements of in-flight and other types of military equipment . . . *conforming to MIL-J-5513A and other specifications.* Barco's wide experience is yours to call upon in the development of your particular project—aircraft, missile, track vehicle or special installation—for hydraulic, pneumatic, oxygen, fuel, gas or liquid service. Barco Representatives are at your service in the specification of standard or specialized adaptations of standard designs.

BARCO MANUFACTURING CO.
566M N. Hough Street • Barrington, Illinois

Serving Industry Since 1908

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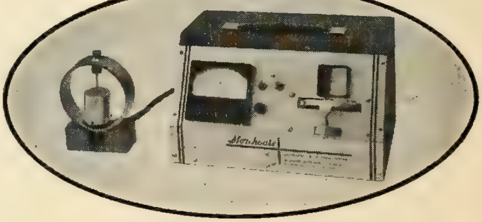
NEW MOREHOUSE CALIBRATING AND WEIGHING SYSTEM

- COMPLETELY TRANSISTORIZED
- BATTERY-POWERED
- EXTREMELY ACCURATE



The new Morehouse Calibrating and Weighing System facilitates the accurate calibration of load cells, thrust stands, torque dynamometers, testing machines and other force measurement equipment. It is also applicable as a prime weighing system where extremely high accuracy is essential.

The System has been transistorized for ruggedness and reliability in addition to making battery operation possible. It is readily portable and easy to operate. For details, write for Bulletin 169.

Morehouse Machine Company
1742 Sixth Avenue, York, Pa.

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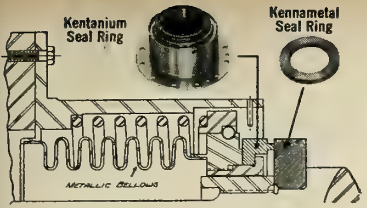

KENNAMETAL*

unlubricated seal rings provide substantially zero leakage at mile-a-minute rubbing speeds

At rubbing speeds of 4200 to 5400 ft./min., the hydraulically balanced seal shown above achieves substantially zero gas leakage. Excellent wear characteristics of Kennametal and Kentanium* Seal Rings make possible unlubricated dry rubbing at peak speeds.

Stein Seal Company, Philadelphia, Pa., solved major sealing problems on many applications by using Kennametal and Kentanium parts in their hydraulic balanced seal design such as illustrated above. Using rings made of these hard carbide, wear-resistant compositions, it is possible to operate with higher spring forces and in much higher temperatures than when rings of conventional sealing materials are used.

The outstanding physical properties of Kennametal compositions provide many more answers to rotary seal ring problems in petroleum refining and transportation, high-pressure high-temperature chemical production and nuclear power. For example, K501, a platinum-bonded carbide, is used to confine liquid oxygen and red fuming nitric acid. Results reported by the customer are "far superior to any previously-used materials, with no indication of face wear."

Various grades of Kennametal compositions hold economical answers to *your* need for high YME, low thermal expansion, high resistance to abrasion, erosion, corrosion, impact and pressures. For positive sealing, with little or no maintenance, mating surfaces of Kennametal Seal Rings can be lapped to a flatness less than two light bands, with a surface finish better than two microinch.

For more information, send for Booklet B-111A, "Characteristics of Kennametal." Write to KENNAMETAL INC., Dept. MR, Latrobe, Pennsylvania

*Trademark 3175

INDUSTRY AND KENNAMETAL
...Partners in Progress

Circle No. 27 on Subscriber Service Card.

received $497,933 for repair parts and electronic components such as resistors, capacitors, inductances and common hardware.

Olin Mathieson Chemical Corp., New Haven, Conn., received $49,484 for feasibility study of fuels based on solids.

By U.S. Army Signal Corps, Fort Monmouth, N.J.:

The DataTape Division, Consolidated Electrodynamics Corp., has received a $148,000-contract award from the U.S. Army Signal Corps for the development of a new type of narrow-band data-recording system.

By District Engineer, U.S. Army Engineer District, Albuquerque, N. Mex.:

Ramsey-Leftwich, Lubbock, Tex., received $209,475 for *Honest John* facilities, White Sands Missile Range, N.M.

By the Department of the Army:

Chrysler Corp., Detroit, Mich., received a $2.1 million contract for the *Jupiter* missile program.

Dean Construction Co., Inc., Long Island City, New York, received $1.9 million contract for construction of a special weapons building at Picatinny Arsenal, Dover, New Jersey.

By U.S. Army Ordnance District, Philadelphia, Pa.:

Western Electric Co., Inc., New York, N.Y., received $983,739 for *Nike* spare parts & components.

Douglas Aircraft Co., Inc., Charlotte, N.C., received $139,510 for *Nike* spare parts & components.

University of South Carolina, Columbia, S.C., received $11,366 for research on "Temperature Dependence on Properties of Electrolytes in Non-Aqueous Solvents."

Minneapolis-Honeywell Regulator Co., Philadelphia, Pa., received a $10,571 contract for *Nike-Corporal* replenishment spare parts.

Western Electric Co., Inc., New York, N.Y., received $180,056 for *Nike* spare parts & components.

By the U.S. Army Signal Corps:

The Electronic Defense Laboratory of Sylvania's Mountain View Lab. received a $3.6-million contract for the manufacture of prototype equipment on a "quick reaction" basis, field support and service, and research and development.

NAVY

By Office of Naval Research, D.C.:

Stencel Aero Engineering Corp., Asheville, N.C. received $40,047 for research and development of a very fast operating powered parachute system.

Bendix Radio, Baltimore, Md., received $335,680 for services involving operation of minitrack satellite tracking system sites.

Columbia University, New York, N.Y. received $36,886 for research and development in the field of metallurgy.

Mellon Institute of Industrial Research, Pittsburgh, Pa., received $70,227 for research on polymer structures and properties.

Purdue Research Foundation, Lafayette, Ind. received $36,000 for research on heat transfer coefficients.

Pennsalt Chemicals Corp., Philadelphia, Pa. received $343,827 for research in the broad field of synthetics and characteristics of inorganic compounds and materials.

FOR THE NAVY'S POLARIS
TITANIUM FOR WEIGHT REDUCTION

(Official U.S. Navy Photograph)

Our metallurgists and engineers will be glad to work with your personnel in developing the most advantageous use of Republic Stainless Steels, Alloy Steels, and Titanium. There's no obligation. Write Republic Steel, Dept. MR-6155A, 1441 Republic Building, Cleveland 1, Ohio

World's Largest Producer of Missile Metals—Titanium, Stainless Steel, and Alloy Steel

REPUBLIC STEEL

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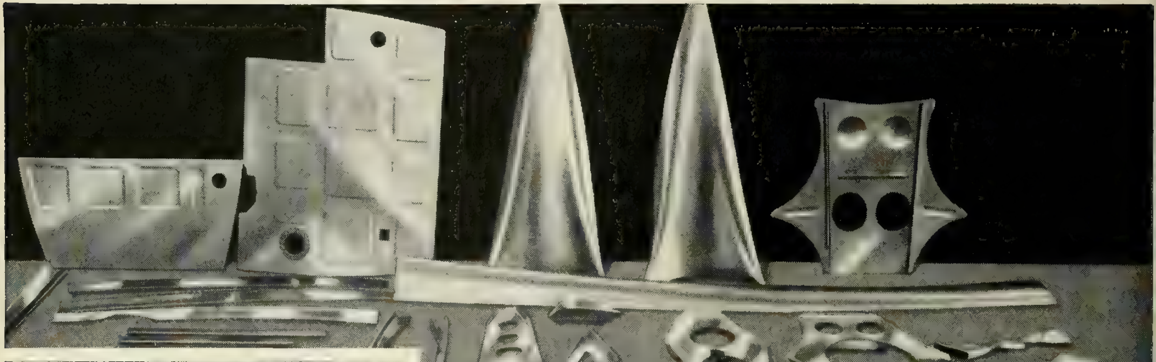
ROHR
AIRCRAFT CORPORATION *takes full advantage of*

TITANIUM'S WORKABILITY



Fabricated Parts
Typical titanium parts fabricated by Rohr Aircraft for aircraft applications.

Drop Hammer Forging—*Oven-heated to 1000° F., commercially pure titanium parts are forged on cold drop hammer dies.*

Stretch Forming—*Titanium sheet is stretch-formed on this huge machine, using electrically heated dies, at Rohr's Chula Vista plant.*

Any doubt in your mind as to titanium's versatility and adaptability for forming and fabrication? Then check these examples from Rohr Aircraft Corporation, Chula Vista, California.

Rohr is a major manufacturer of aircraft parts and airframe components. It uses Mallory-Sharon commercially pure titanium and titanium alloys for many of its forged and fabricated parts . . . takes full advantage of the material's workability, as well as its high strength-to-weight ratio, excellent corrosion resistance and high temperature properties.

May we help *you* gain more benefit from titanium's unusual capabilities? Our experienced Service Engineering group is ready to assist you. Or write for new bulletin on *Commercially Pure Titanium.*

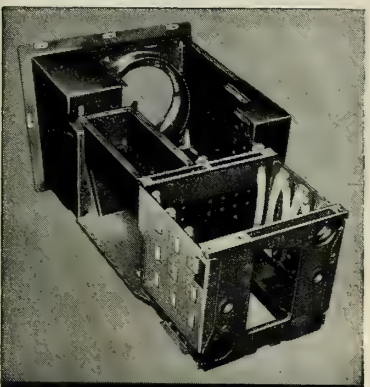
MALLORY MS **SHARON**

MALLORY-SHARON METALS CORPORATION • NILES, OHIO

Integrated producer of Titanium • Zirconium • Special Metals

Circle No. 55 on Subscriber Service Card.

CONVEX?
CONCAVE?
COMPLEX?



KAMAN
CAN
BUILD IT

HOUSINGS
FOR
AIRBORNE
ELECTRONICS

Complete manufacturing, processing and inspection facilities housed in 500,000 feet of plant space ideally qualify Kaman to produce housings and chassis for even the most intricate airborne electronic equipment. Kaman's experience in producing parts of magnesium and the other aircraft metals to rigid tolerances and specifications has earned it a part in several missiles and rockets programs. Have you considered Kaman? Write for equipment list and illustrated facilities brochure to J.W. Marshall, Manager.

SUBCONTRACT DIVISION
THE KAMAN AIRCRAFT CORPORATION
BLOOMFIELD 9 CONNECTICUT

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when and where

NOVEMBER

Fifth Institute on Electronics in Management, American University, Washington, D.C., Nov. 3-7.

13th Annual Symposium on Applied Spectroscopy, Hotel New Yorker, New York, Nov. 6-7.

Institute of Radio Engineers, Fifth Annual Meeting Professional Group on Nuclear Science, Villa Hotel, San Mateo, Calif., Nov. 6-7.

National Defense Transportation Association, 13th Annual Convention and Logistics Forum, Sheraton-Jefferson Hotel, St. Louis, Mo., Nov. 9-12.

School of Aviation Medicine, International Conference, Physics and Medicine of the Atmosphere and Space, Hilton Hotel, San Antonio, Texas, Nov. 10-12.

Society for Experimental Stress Analysis, 1958 Annual Meeting, Hotel Sheraton-Ten Eyck, Albany, N.Y., Nov. 12-14.

National Security Industrial Association, Symposium on Molecular Electronics, Washington, D.C., Nov. 13-14.

Conference on Scientific Information, AFOSR/Directorate of Research Communication, NAS, NSF, and the American Documentation Institute, Mayflower Hotel, Washington, D.C., Nov. 16-21.

American Society for Quality Conference, Sixth Annual Aircraft and Missile Division Conference, Biltmore Hotel, Dayton, Ohio, Nov. 17-18.

American Rocket Society, 13th Annual Meeting and Astronautical Exposition, Hotel Statler, New York, Nov. 17-21.

Eighth National Plastics Exposition, International Amphitheatre, and Plastics Conference, Hotel Morrison, Chicago, Nov. 17-21.

Northeast Electronics Research and Engineering Meeting, Mechanics Hall, Boston, Nov. 19-20.

Lockheed Missile Systems Division's Research Laboratory, Third Symposium on Magnetohydrodynamics, Palo Alto, Calif. Attendance by invitation, Nov. 21-22.

The Convertible Aircraft Congress, designing and operating missiles from unprepared sites, Franklin Institute, Philadelphia, Nov. 28.

DECEMBER

Electronic Industries Association Third Conference, Reliable Electrical Connections, Dallas, Dec. 2-4.

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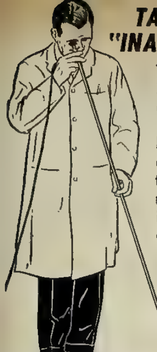

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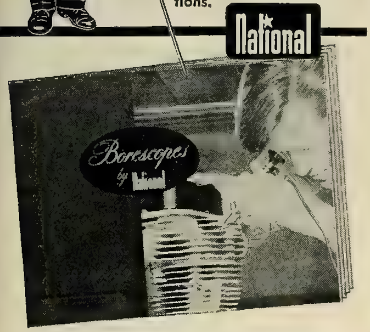

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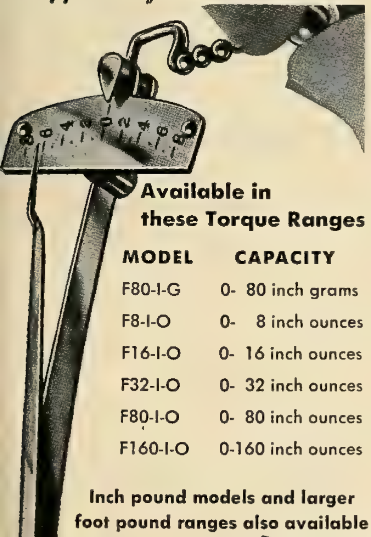

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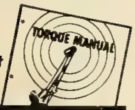

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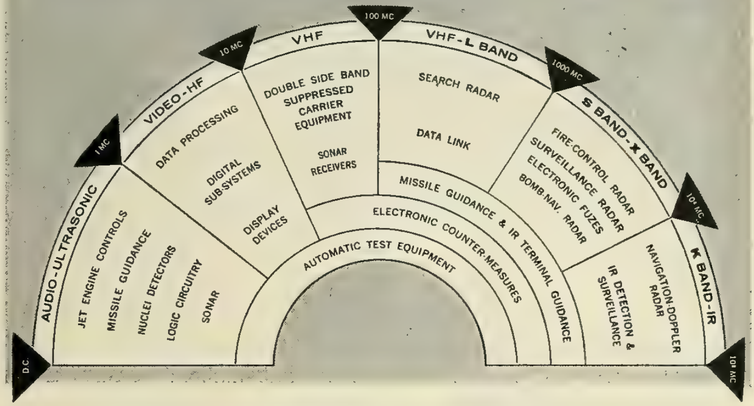

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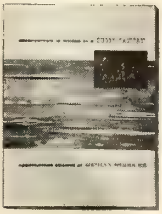

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AiResearch Aviation Service Co., Div.-The Garrett Corp. 51
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American Brake Shoe Co. 4
Agency—Fuller & Smith & Ross, Inc.
Ampex Corp. 41
Agency—Boland Assoc.
Avco Mfg. Corp., Crosley Div. 22
Agency—Robert Acomb, Inc.
Barco Mfg. Co. 62
Agency—Armstrong Adv. Agency, Inc.
Bendix Aviation Corp., Red Bank Div. 54
Agency—MacManus, John & Adams, Inc.
Boeing Airplane Co. 25
Agency—Calkins & Holden, Inc.
Bristol Co., The 53
Agency—James Thomas Chirurg Co., Inc.
Camco Fittings, Inc. 28
Agency—Vincent Pacelli, Adv.
Caterpillar Tractor Co. 13
Agency—N. W. Ayer & Son, Inc.
Chance Vought Aircraft, Inc. 36, 37
Agency—Tracy-Locke, Inc.
Christie Electric Corp. 16
Agency—Len Woolf Co.
Consolidated Electrodynamics Corp. 24
Agency—The Rumrill Co., Inc.
Dyna-Therm Chemical Corp. 18
Agency—Taggart & Young, Inc.
Electro Instruments, Inc. 72
Agency—Clyde D. Graham Adv.
Engelhardt Industries, Inc. 67
Agency—Stuart Sande Adv.
Excelco Developments 20
Agency—Melvin F. Hall, Adv. Agency, Inc.
Gaertner Scientific Corp., The 69
Agency—Sidney Clayton & Assoc.
General Electric Co. 23
Agency—G. M. Basford Co.
Grove Valve & Regulator Co. 71
Agency—L. C. Cole Co.
Hallamore Electronics Co., A Div.-The Siegler Corp. 19
Agency—Cole, Fischer & Rogow, Inc.
Haws Drinking Faucet Co. 61
Agency—Pacific Adv. Staff
A. W. Haydon Co., The 45
Agency—Cory Snow, Inc.
Hayward Scientific Glass Corp. 55
Agency—L. J. Swain, Adv.
Humphrey, Inc. 56
Agency—The Phillips-Ramsey Co.
International Business Machines Corp. 26
Agency—Benton & Bowles, Inc.
Kaman Aircraft Corp. 65
Agency—Charles Palm & Co., Inc.
Kennametal, Inc. 63
Agency—Ketchum, MacLeod & Grove, Inc.
Kollmorgen Optical Corp. 39
Agency—Wilson, Haight, Welch & Grover, Inc.
Laminated Shim Co. 33
Agency—Wilson, Haight, Welch & Grover, Inc.
Lebanon Steel Foundry 52
Agency—Howard E. Marshall, Adv.
Lockheed Aircraft Corp., Missiles Systems Div. 44
Agency—Hal Stebbins, Inc.
Loewy-Hydropress Div. of Baldwin-Lima-Hamilton Corp. 10
Agency—Gray & Rogers
Mallory-Sharon Titanium Corp. 64
Agency—The Griswold-Eshleman Co.
Jas. H. Matthews & Co., Inc. 32
Mayer's Grand Guide 40
Minneapolis-Honeywell Regulator Co.
Boston Div. 8
Agency—Louis K. Frank Co.
Micro Switch Div. 59
Agency—Reincke, Meyer & Finn, Inc.
Missile & Space Systems Div., United Aircraft Corp. 42
Agency—G. F. Sweet & Co., Inc.
Morehouse Machine Co. 62
Agency—George F. Walsh Adv. Agency
New Departure Div., General Motors Corp. .. 3
Agency—D. P. Brother & Co.
Non-Linear Systems, Inc. 2
Agency—Barnes Chase Co., Inc.
North American Aviation, Inc.
Autonetics Div. 6
Missile Div. 38
Rocketdyne Div. 34, 58
Agency—Batten, Barton, Durstine & Osborn, Inc.
Propellex Chemical Corp. 45
Agency—Al Maescher Adv., Inc.
Pure Carbonic Co., a Div. Air Reduction Sales Co., Inc. 47
Agency—G. M. Basford Co.
Radio Corp. of America 27
Agency—Al Paul Lefton Co., Inc.
Raybestos-Manhattan, Inc. 17
Agency—Gray & Rogers
Republic Aviation Corp. 43
Agency—Deutsch & Shea, Inc.
Republic Steel Corp. 61, 63, 65
Agency—Meldrum & Fewsmith, Inc.
Resistoflex Corp. 40
Agency—Marsteller, Rickard, Gebhardt & Reed, Inc.
Robertshaw-Fulton Controls Co., Fulton Sylphon Div. 46
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Sanborn Co. 35
Agency—Culver Adv., Inc.
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Agency—Richard & Gunther, Inc.
P. A. Sturtevant Co. 67
Agency—Ross Llewellyn, Inc.
Thompson Products, Inc. 50
Agency—Meldrum & Fewsmith, Inc.
Titanium Metals Corp. of America 49
Agency—W. L. Towne Adv.
United Aircraft Products 60
Agency—Weber, Geiger & Kalat, Inc.
Vinco Corp. 53
Agency—Rolfe C. Spinning, Inc.

EMPLOYMENT SECTION
Bendix Aviation Corp., Bendix Products Div. .. 68
Agency—MacManus, John & Adams, Inc.
General Electric Co. 67
Agency—Deutsch & Shea, Inc.
System Development Corp. 66
Agency—Stromberger, LaVene, McKenzie

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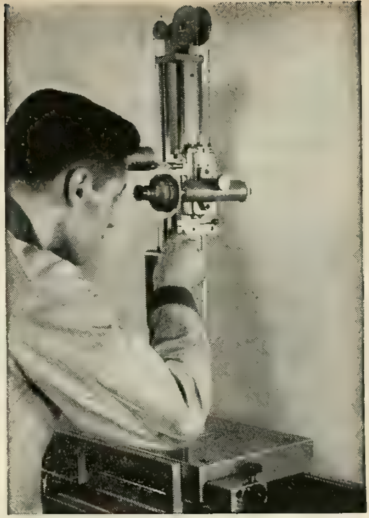

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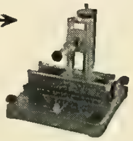

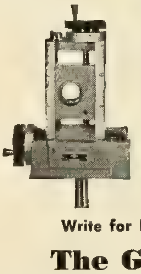

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Road To Space Technology Success

Five months after the launching of *Sputnik* I, the Defense Department established ARPA (Advanced Research Projects Agency), and less than a year after *Sputnik* II Congress established NASA (National Aeronautics and Space Administration)—*two* space agencies.

We've said it before, and we'll say it again: Our space experts, many members of Congress, and representatives from the missile industry have watched with dismay the slow-moving space program in the United States. In view of Russia's energetic missile and rocket programs, it is almost unbelievable that the American public is allowed to remain unaware that we are not in a race with the Russians for space superiority. Perhaps the most incredible aspect of our falling behind the Reds is that we had and still have the necessary know-how and scientists to beat them.

In contrast to the 12-year-old, fully coordinated and massive Red rocket effort, America's interest in rocketry didn't even begin to assume importance until 1952. Since then, it has had more of a chaotic appearance than organization. Only a few years ago advocates of rocketry and space flight were ignored when they attempted to submit their proposals. When the Russians set up their Astronautics Commission, a proposal to do almost the same thing in this country was collecting dust on a Washington office shelf.

Astronautics will not be used solely for peaceful purposes until the world has learned to solve its problems without resort to war. An attempt to "sanitize" space would be a futile procedure and would be fraught with extreme danger for the free world. Military spacecraft offers the possibility for breaking the greatest advantage the Soviet Union possesses: the advantage of secrecy; the advantage that may one day crush the Western world in one overwhelming surprise attack. We must not deliberately blind our new-found eyes. Astronautics must be freed to pursue its own destiny, unfettered by preconceived artificial limitations of personnel, organizations, or scope. It must be headed by enthusiasts and supported with vigor by the government.

In the face of heavy partisan politics by entrenched organizations whose primary interests in space are the preservation of their own hold on the taxpayer's dollar, the end is being subordinated to the means, with disastrous consequences. When first things come last, the result is chaos and waste.

Only a unified effort can put us first in the conquest of space now. We need *one* organization with no other objectives. We didn't create a Manhattan Project to develop atomic bombs and baby buggies. Astronautics, too, is unique. It deserves a unique organization. Singleness of purpose is required. *One organization* to develop *all* space devices (because military and scientific goals must advance hand in hand) is what we must have.

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SIGNAL COMPARATOR. A precision Signal Comparator that monitors missile "readiness," and which can monitor any required number of signal channels simultaneously has been announced by Avien, Inc. The Comparator, developed by Avien for a still classified USAF weapon system, is designed for use in either airborne or ground checkout applications, and other applications where equipment readiness is indicated by a specified level of signal voltage. In addition, the unit can be readily integrated with larger systems for automated control and sequencing applications.

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CATHODE BULBS. Cathode ray bulbs made of optical quality high temperature alumina-silicate glass are now available from Corning Glass Works. Virtually free of physical imperfections, the bulbs are particularly applicable to high resolution radar surveillance systems. Alumina-silicate glass can be optically melted. Flaws can be held to .001 of an inch or less in size.

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FILTERS. A new line of Model 12680 heavy-duty in-line T filters for ground equipment use is now available from Bendix filter division. The filters are designed to achieve maximum application flexibility at minimum design cost. One basic design with an interchangeable element can be supplied with different flange sizes.

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76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100
101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125
126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150
151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175

● ● **Missile Literature**

200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224

● ● **New Missile Products**

225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249
250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274
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POTENTIOMETERS. Data sheet 1362 gives details of Helipot Series 5200, a new all-metal, 1-1/16 in. diameter servo-mounting potentiometer. The four-page publication includes complete specification, including environmental.

Circle No. 211 on Subscriber Service Card.

FILTERS. ERA Electric Co. has published a new catalog sheet containing descriptive material on its new line of transistor transient filters. These units are connected at the DC input of transistorized inverters-converters, frequency changers and switching circuitry.

Circle No. 212 on Subscriber Service Card.

MANUAL. General Electric Co. announces a third edition of its transistor manual, first introduced in 1957 to present to engineers and technicians a handy reference guide on available transistors, and how to use them.

Circle No. 213 on Subscriber Service Card.

COMPUTERS. Electronic Associates, Inc., has published a new booklet describing in detail the analog computing equipment installed in the company's three computing centers.

Circle No. 214 on Subscriber Service Card.

SCORING. A 28-page pamphlet on missile scoring systems is offered by Traid Corp. It illustrates many pilotless drones and optical scoring systems in action.

Circle No. 215 on Subscriber Service Card.

ALLOY FABRICATION. A 30-page booklet entitled "Guide for Purchasing Complex and Unusual Alloy Sheet and Light Plate Fabrication" describes and illustrates the types of products and equipment produced by S. Blickman, Inc. Detailed descriptions and over 80 photographs and sketches of products and fabricating techniques make this booklet a permanent handy reference manual for management; design, development, and process engineers; and purchasing agents.

Circle No. 216 on Subscriber Service Card.

ANTENNA. A radar antenna system designed for ultra-precision tracking of the Talos missile is described in a bulletin published by Special Products Division, I-T-E Circuit Breaker Co. The four-page publication describes details of design, fabrication and testing.

Circle No. 203 on Subscriber Service Card.

OSCILLOSCOPES. An illustrated bulle
details the Industrial Products Divisi
of ITT's most recently developed I
and 21-in. oscilloscopes built to me
ure voltages and currents in the fr
quency range from DC to 250 KC. T
scopes provide a linearity of better th
1% over a calibrated scale 10 in.
15 in.

Circle No. 206 on Subscriber Service Ca

AIR CONDITIONING. Latest designs
missile support air conditioning equi
ment are illustrated in a four-page b
chure issued by C. G. Hokanson C
Inc.

Circle No. 207 on Subscriber Service Ca

HOSE FITTINGS. A new catalog on
Flexon Aeronautical Synthetic and Flex
T hose assembly fittings has been
sued by Flexonics Corp. The 15-pa
booklet lists product types, and th
military parts numbers.

Circle No. 208 on Subscriber Service Ca

TRANSISTORS. Prices, specificatic
and design details of three Sperry tr
sistor types are included in data shee

Circle No. 200 on Subscriber Service Ca

ELECTRONIC CIRCUITS. Free b
chures outlining transistorized electro
circuits for the engineer and stude
are available from Motorola Inc.'s Sen
conductor division.

Circle No. 201 on Subscriber Service Ca

HARDWARE. A reference manual
standard electronic hardware facilitat
selection and procurement by equi
ment manufacturers. The 75-page boo
let, prepared by Amatom Electro
Hardware Co., contains photos, di
grams, dimensions and sizes of mo
than a hundred types of standard pa
available directly from stock.

Circle No. 202 on Subscriber Service Ca

THERMOCOUPLES. A 36-page catal
shows the complete line of therm
couple assemblies and pressure seali
glands manufactured by Conax Co
Also included are new additions, su
as Conax Type C bare wire therm
couple glands, Conax roll temperatu
thermocouples, and other products.

Circle No. 205 on Subscriber Service Ca

REFRACTORIES. A report that revie
development of high temperature
fractories for use in rockets has be
released for industry by the Naval O
nance Test Station. The material brin
together scattered literature on refr
tories that has appeared up to 1955.

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NOVEMBER 3, 1958

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26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
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151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

• • Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

• • New Missile Products

225	225	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

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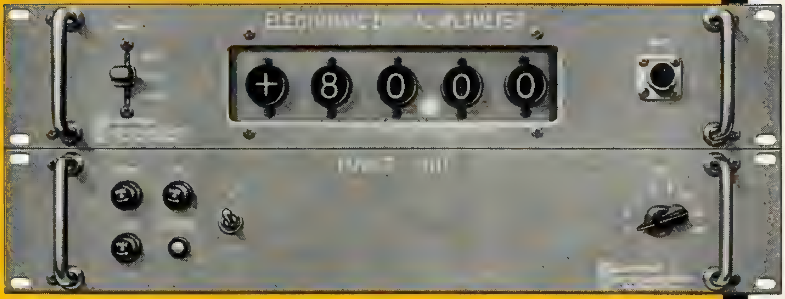

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Both the 7000 and 8000 Series develop voltage state BCD outputs for data recorder entry. Standard code is 2, 4, 2, 1; other codes available on special order.

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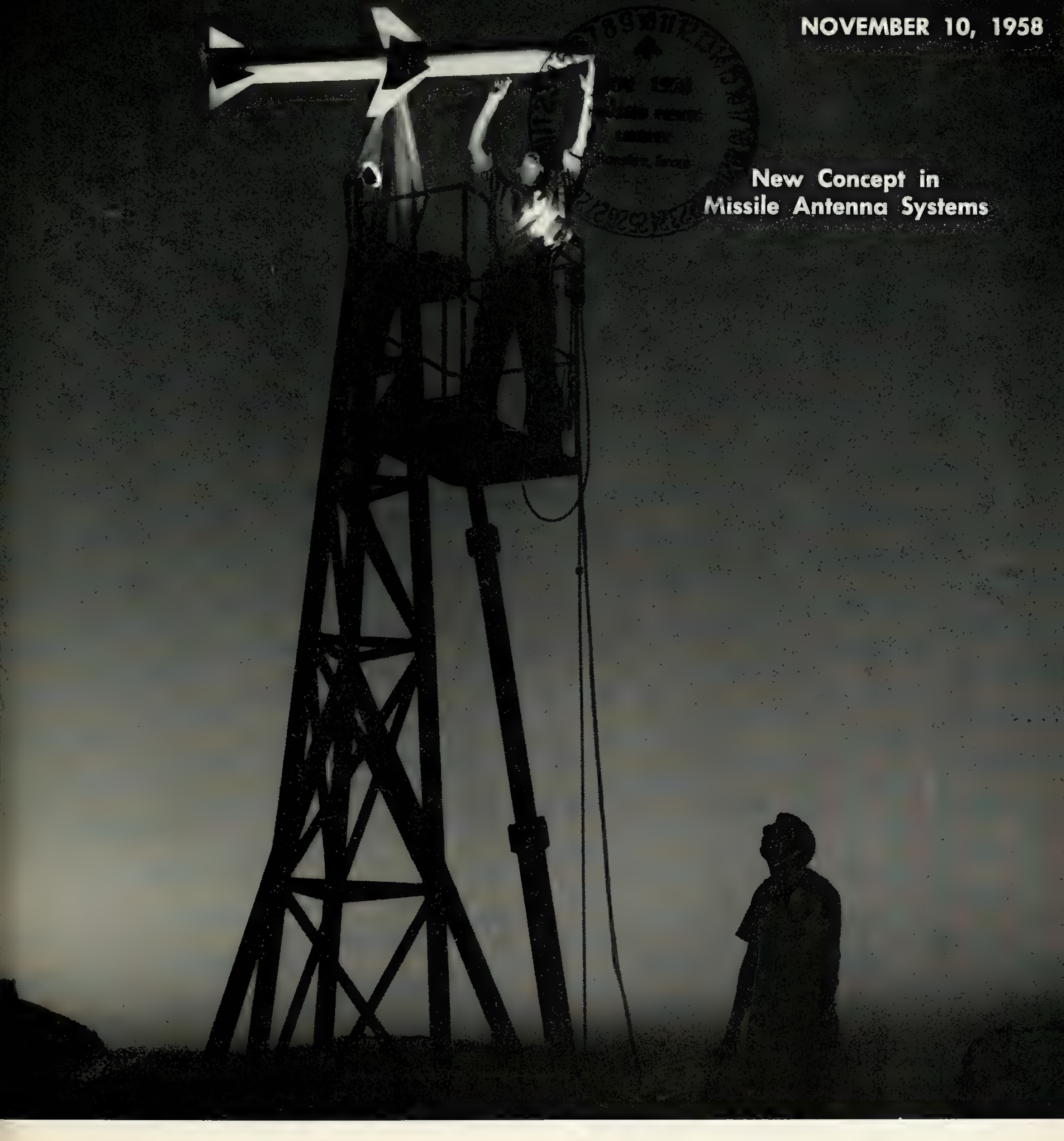
NOVEMBER 10, 1958



New Concept in Missile Antenna Systems

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

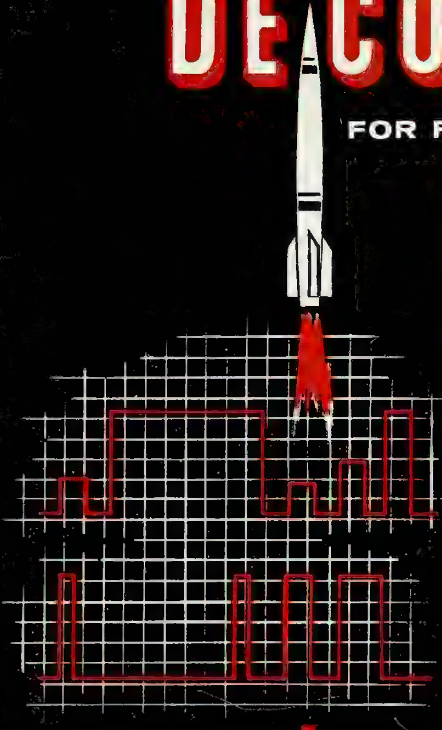
News and Business Edition

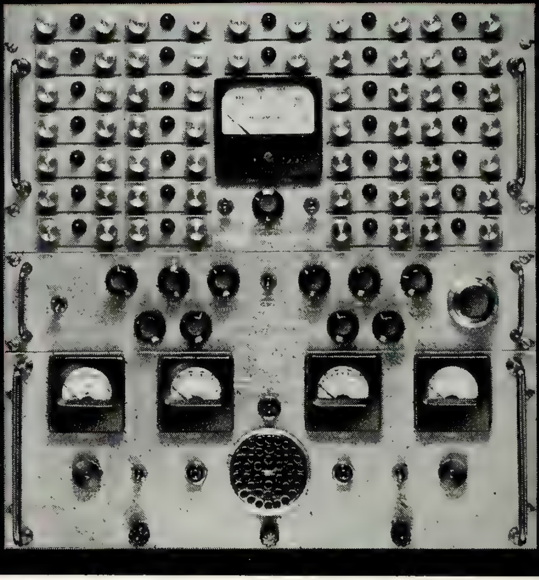
AN AMERICAN AVIATION PUBLICATION

New....ARNOUX miniature

DE COMMUTATOR

FOR PAM and PDM TELEMETRY SYSTEMS





The new Arnoux Model TDS30-1 Decommutation System is completely self-contained within three chassis assemblies consisting of: Gating Unit (TOP), Pulse Selector (MIDDLE) and Regulated Power Supply (BOTTOM). The unit handles 28 channels of information and occupies only 19½ inches of panel height in a standard relay rack. Overall depth behind panel is 13 inches.

The Arnoux Model TDS30-1 Decommutation System is compactly designed for use in airborne or trailer installed telemeter receiving stations and in portable check-out equipment.

- Miniaturization is the natural result of a new circuit design allowing the entire system to contain only 76 tubes as opposed to several hundred in competitive systems.
- Modular construction permits easy expansion of system to any desired channel capacity.
- Novel circuitry design does not reflect errors due to center frequency drift of sub-carrier oscillators, drift of discriminator D. C. output level, or tape playback speed errors.
- Built-in test selector permits visual inspection of waveforms throughout system for quick malfunction detection.
- Neon indicators on each gating unit give continuous visual indication of correct sequential operation.
- System accepts all standard IRIG inputs, either PAM or PDM, at any sampling rate from 75 to 900 per second.
- Overall linearity is within ± ½ % at maximum level. Long term level drift is within ± ½ %. Gain drift is negligible.
- Modular plug-in gating units allow quick replacement of faulty channels.
- Two spare units are maintained on standby for instant use.
- Power required is 115 volts, 60 cps, single phase. Optional 115 volt, 400 cps, power supply available for airborne application.

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ARNOUX BULLETIN 800

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Designers and Manufacturers of Precision Instrumentation

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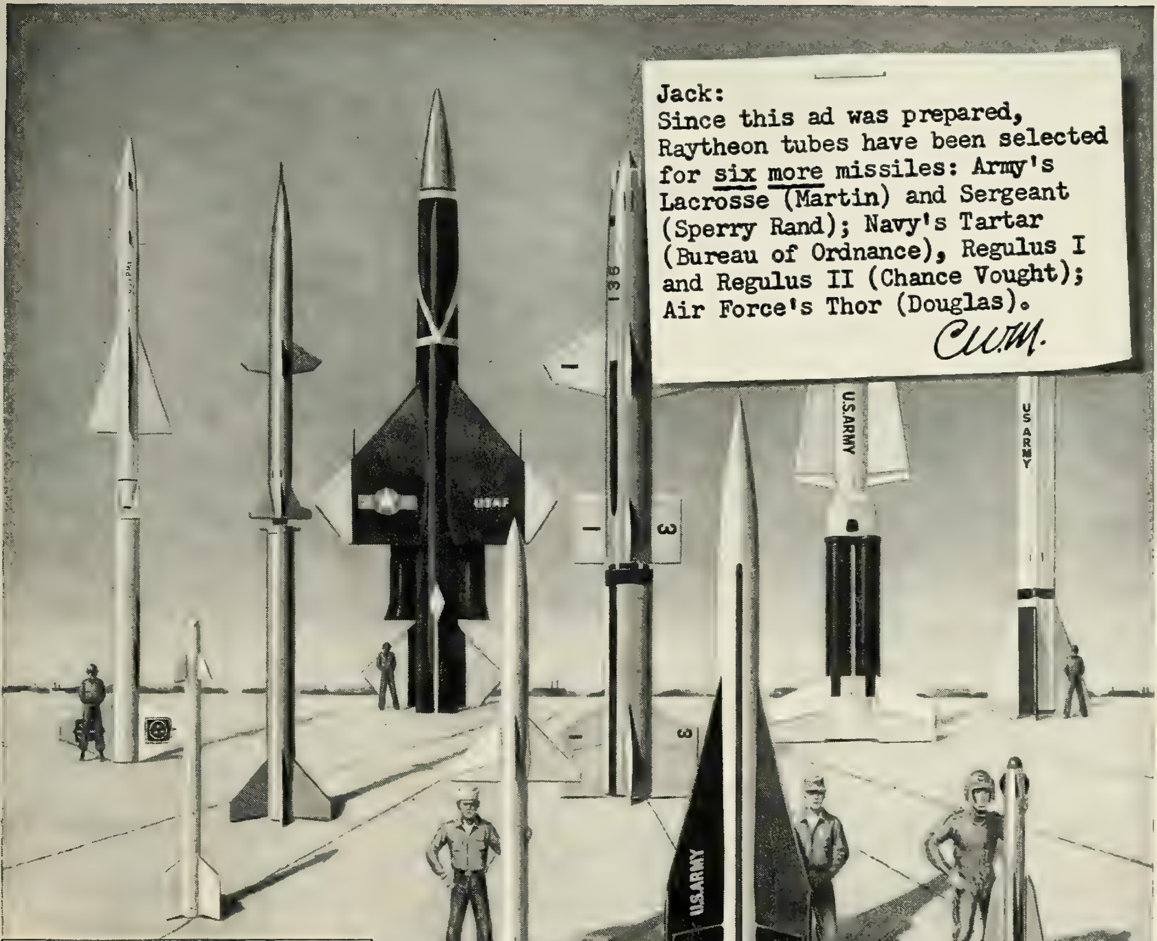
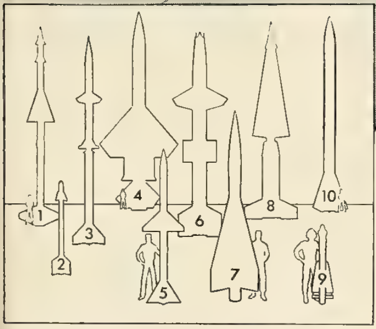


Jack:
Since this ad was prepared, Raytheon tubes have been selected for six more missiles: Army's Lacrosse (Martin) and Sergeant (Sperry Rand); Navy's Tartar (Bureau of Ordnance), Regulus I and Regulus II (Chance Vought); Air Force's Thor (Douglas).
CWM.



1. **Nike Ajax.** Army. Ground-to-air. Prime contractor: Western Electric.
2. **Sidewinder.** Navy. Air-to-air. Prime contractors: Philco; General Electric.
3. **Terrier.** Navy. Surface-to-air. Prime contractor: Convair.
4. **Bomarc.** Air Force. Ground-to-air. Prime contractor: Boeing.
5. **Sparrow III.** Navy. Air-to-air. Prime contractor: Raytheon.
6. **Talos.** Navy. Surface-to-air. Prime contractor: Bendix.
7. **Hawk.** Army and Marine Corps. Ground-to-air. Prime contractor: Raytheon.
8. **Nike Hercules.** Army. Ground-to-air. Prime contractor: Western Electric.
9. **Falcon.** Air Force. Air-to-air. Prime contractor: Hughes Aircraft.
10. **Corporal.** Army. Ground-to-ground. Prime contractors: Firestone; Gilfillan.

10 MAJOR U. S. MISSILES RELY ON RAYTHEON TUBES

Crushing acceleration and searing heat must be endured by the electronic tubes in guided missiles. Even under these grueling conditions, tiny Raytheon tubes produce guidance impulses with steadfast *reliability.* This reliability is achieved through capable engineering and painstaking manufacturing and testing techniques.

The choice of Raytheon Reliable subminiature tubes for use in these 10 missiles is another example of how the 31,000 men and women of Raytheon are contributing to the nation's security.

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SARASOTA BRADENTON AIRPORT, P.O. BOX 3142, SARASOTA, FLORIDA

COVER: *Technicians from the Electronic Specialty Co., Los Angeles, position a scale model of a missile for tests of an integrated radiating system. Concept of systems engineering for complete communications package is thought to be necessity for missiles of the future (Page 30).*

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missiles and rockets Vol. 4, No. 19, Nov. 10, 1958

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in this issue

NOV. 10 HEADLINES

***Atlas-D* To Be Used for First U.S. Manned Satellite**
Exclusive by m/r gives specifications and flight program of NASA-ARPA satellite capsule 13

U.S. Mobilizing Free World Brain Power
Top European scientists pushing space research in some 350 contracts to give U.S. new avenues of technical know-how 13

Missile Investments Boosted in Chicago
Mutual fund organized by astronautics, rather than Wall Street 16

Cincinnati: Job Shop for Missile Industry
This m/r special report gives industry participation in an area known for its strong secondary position in parts manufacturing 19

ASTRONAUTICS ENGINEERING

Frangible Plastic Case Proven on *Nike* Booster
Epoxy resins aid in reinforced plastics 27

MISSILE ELECTRONICS

Integrated Package Is Must for Antennas
All antenna components should be matched to eliminate discontinuity and power loss 30

Infrared Detector Uses Germanium in Conductor 32

DEPARTMENTS

In My Opinion 7
Washington Countdown ... 9
Industry Countdown 11
Propulsion Engineering ... 22
When and Where 24
West Coast Industry 24
Contract Awards 34
Letters 34

Every Job is an Interesting Job at DIVERSEY!

Above you see a recent one. It is a high pressure accumulator for a missile being finish machined by a Diversey craftsman. It's a tough alloy steel and the job requires closely controlled tolerances.

What makes this job interesting and significant to you is that Diversey can take a forging, run it through automatic contour turning operations, and finally apply the expert finish machining being done above.

Diversey does outstanding work in missile metal machining because they have the finest machinists, the largest facilities, and alert, capable, and progressive technical people. Bring your interesting and tough jobs to Diversey.

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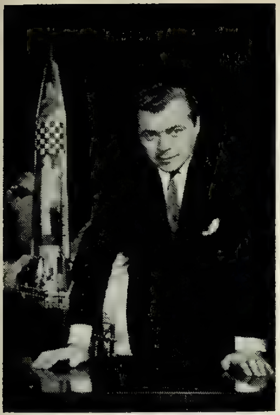


In My Opinion . . .

. . . NASA is to be commended for its quick and foresighted action in taking immediate steps to invite industry to bid on our first worthwhile manned satellite study vehicle (see page 13). Only three weeks after its birth, NASA—on October 21—sent out a 31-page invitation to industry to bid. A classified meeting of interested bidders was scheduled to be held at Langley Field, November 7. Obviously, Administrator T. Keith Glennan is determined to show industry he means business. Congratulations!

There's one important thing, however, that should not be overlooked about this undertaking: this is a joint NASA and ARPA undertaking! In the invitation to industry to bid NASA says in the very first sentence of the accompanying letter: "The National Astronautics and Space Administration, with the Assistance of the Advanced Research Projects Agency of the Department of Defense, is initiating a manned satellite project."

In other words, one of our first and most important space projects to date is scheduled as a joint ARPA-NASA venture; obviously because of the overlapping military and scientific interests. This approach has been and will continue to be inevitable for most space projects as long as the world is not at peace.

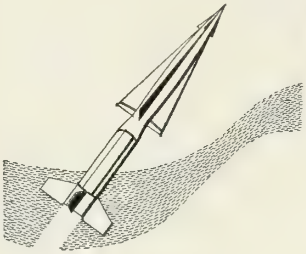
It is gratifying to us that one of the country's top astronautics experts, ARPA's Captain Robert Truax, in a speech before the American Rocket Society's National Capital Section in Washington a week ago, constructively suggests the establishment of a Space Center to coordinate ARPA and NASA programs for the sake of efficiency and practicality. It is also worth while to note that Truax' speech was cleared by Murray Snyder's security review censors—which might indicate that the Truax proposal possibly has the blessing of the Department of Defense.

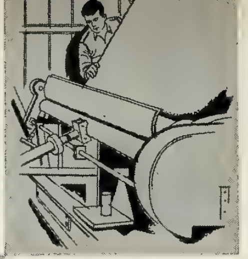
Truax believes some of our actions in the past year have been somewhat frantic and not too well considered. Fortunately, he says, only three actions are necessary to set us on the right track. First, we must create an integrated organization devoted to the technical planning and management of the space program and answerable to both ARPA and NASA. Second, we must realize that the conquest of space is primarily an engineering problem to achieve a military objective, not, perhaps unfortunately, a scientific problem to achieve a humanitarian objective. Thirdly, we must devote a major effort to larger and more efficient space vehicles. Truax also added a fourth: "We must reach an adequate level of financing and sustain this level until we are definitely the world leader in space. The alternatives to what I propose are either tremendous expense, permanent loss of control of space to the U.S.S.R., or both."

We agree with you Bob Truax—one hundred per cent.

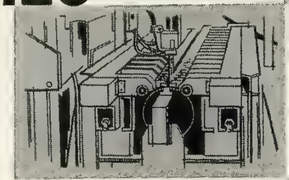
Erik Bergaust

CAPABILITIES AND FACILITIES

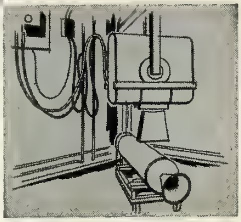




New methods in forming rocket motor body shell.



Welding facilities assure strong, uniform welds.



Xray-inspection before annealing.

National Electric's Contribution to The Rocket and Missile Program

ENGINEERING... A staff of engineering specialists with extensive backgrounds in physics, mathematics, stress analysis, metallurgy, thermodynamics, hydraulics, electronics and structural, mechanical and electrical design. Their efforts have resulted in mass production methods and techniques for the fabrication of rocket bodies and components faster, more economically and to closer tolerances than ever before achieved.

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MASS PRODUCTION... Mass production has been achieved through continuing technical advancements and modern techniques. Currently extensive research and development projects are being conducted on several highly critical and important rocket motor bodies including mass production on the Nike Hercules.

Write for your free copy of our Rocket and Guided Missile booklet. Our experience can be an added asset to your experience.

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Advanced heat-treating methods developed by National Electric provide new and highly important b through in rocket and missile production.

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ROCKET AND GUIDED MISSILE DIVISION

National Electric Products Corporatio

TWO GATEWAY CENTER • PITTSBURGH 22, PA.

washington countdown

Lunar probsters preparing . . .
for November attempt as m/r went to press. High hopes were held for the shoot scheduled for early morning hours of November 7. NASA was to have had complete control with an information center in Washington. Steps have been taken to remedy control problem which prevented October vehicle from attaining programmed velocity because of guidance error. Increased angle caused gravity measuring gear to be shutting off first stage with several seconds fuel remaining.

Third probe . . .
except for improved scanner, will be essentially the same. NASA estimates chances of complete success (moon orbit) are about 25-to-1. Speed of 24,000 mph is required with guidance angle accuracy within 0.2 degrees.

Space Liaison Board . . .
named last week should lessen chances of future hassles such as developed when NASA asked for Army's Huntsville scientists. President named William M. Holaday as chairman of the civilian-military liaison committee for space and air matters. This may indicate that Holaday's position as director of guided missiles could be eliminated when a DOD Director of Research and Engineering is appointed. NASA members are: Hugh Dryden, Abe Silverstein, Homer J. Stewart and Ira H. Abbott. Military will be represented by one civilian—ARPA Director Roy Johnson—and three service reps: Maj. Gen. W. W. Dick, Army; VAdm. R. B. Pirie, Navy; and Maj. Gen. R. P. Swofford, Air Force.

One report . . .
gaining momentum in Capital circles is that DOD asked NASA to take Army space team and not vice versa, in an effort to solve some of the roles and missions problems. Could this account for DOD looking other way while Army's Trudeau and Maderis openly protested proposal?

No limitless budget . . .
is envisioned for NASA. Presidential Space Advisor Killian's suggestion for unlimited funds for investigating space isn't seriously taken at NASA. First, it takes some time to organize, even to spend money. And, Harry Byrd is still chairman of the Senate Finance Committee.

Deep in the heart of . . .
Texas will be the first *Nike-Hercules* sites for the Lone Star state. Contract for $4.1 million went to Kind Construction of Texarkana for work on four *Hercules* air defense sites in Dallas-Fort Worth area.

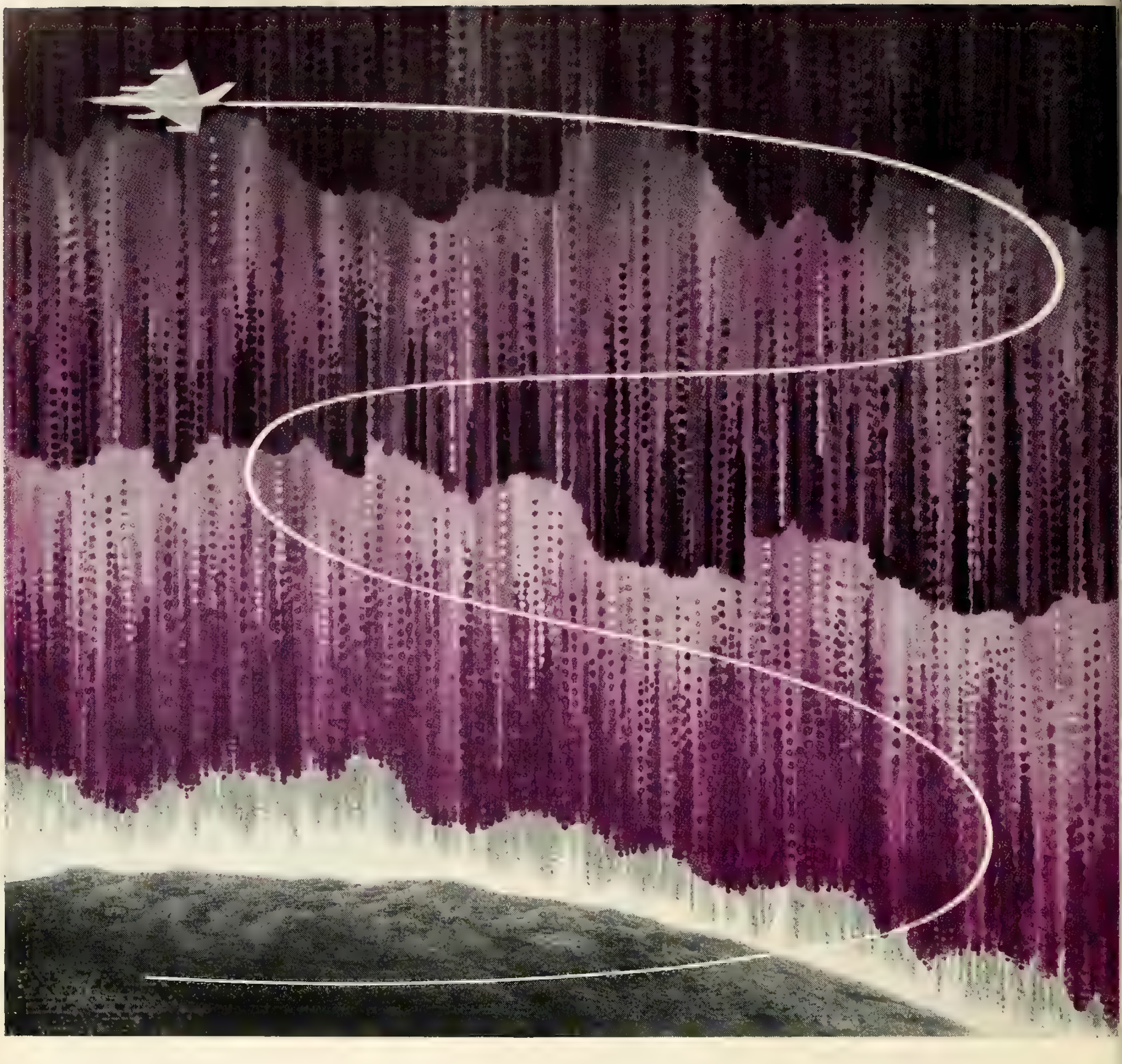
"Shrine of secrecy" . . .
is scored by report from the Moss Congressional committee on information. "Congress is no longer a band of silent men," the report said, and the right to know is fundamental. Report lists legislative developments in this area during the 85th Congress, which "serve as a warning to those executive officers who continue to worship at the shrine of secrecy."

Setting sights on sites . . .
is as far as U.S. has gone in locating missiles overseas. Trouble stems from agreeing to British insistence that natives man the bases in UK. Now other nations want to do same, but lack technical personnel. The three British sites are the only ones really nailed down for *Thors* or any IRBM. Three other *Thor* squadrons are planned for Alaska, and three are hoped for in Turkey, but that will take time.

***Jupiters* to Italy . . .**
is another fond hope, but not definite yet. Failure of France to close deal for *Jupiter* set search in motion for other homes.

***Nikes* are being readied . . .**
for deployment to several areas including Holland, Norway and Italy. Meanwhile, reports persist that when NATO countries demonstrate ability and know-how to make them, they will get blueprints for *Hawk* and *Sidewinder*.

R&E Director . . .
still wanted and military missile men are concerned about the failure of the administration to find someone to take the job with only two years of administration remaining, top jobs continue to go wanting. And when they are filled it is by "alternates", several steps down the line.



New extreme-high-temperature lubricants for missiles and supersonic aircraft **SHELL ETR GREASES**

One of the serious lubricating problems faced by designers of missiles and supersonic aircraft has been solved by scientists at Shell Research Laboratories.

The problem: to find a grease which would permit components to operate with certainty under extreme high temperatures. Co-operation with representatives of bearing manufacturers and military personnel resulted in a completely new class of greases—SHELL ETR GREASES.

These greases can easily withstand temperatures up to 600°F. They give superior lubricating performance because of a special thickener—an organic vat dye—which has exceptional heat stability and jelling efficiency.

If you are presently in the market for an ultra-high-temperature-range grease, we will be glad to provide more information on Shell ETR Greases.

SHELL OIL COMPANY

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100 Bush Street, San Francisco 6, Calif.

SHELL

industry countdown

Bright earning outlook . . .

for Thompson Ramo-Wooldridge Inc., the name of the affiliate property acquisition of Thompson, is predicted. Total sales for the merged company is expected to be in excess of $325 million with a promise of an upward trend in sales and earnings for fiscal 1959. Space Technology Labs, which has been an autonomous division of Ramo-Wooldridge, was established last month as a separate subsidiary corporation with complete operational independence.

The heralded misfire . . .

of the Navy's second operational test *Polaris* could be attributed to propellant casing failure. Aerojet, propellant contractor, reports that the casing stress band at the top of the first stage gave way with the resultant loss of the upper chamber head. With the complete loss of pressure, the propellant proceeded to burn steadily for six minutes. The second stage blasted off eight-tenths of a second later when flames from the first stage entered the nozzle. However, a top ranking Navy official said *Polaris* failed when a malfunctioning of part of the destruct system lead to an abortion of the first stage and set off the firing mechanism of the second stage. Take your choice.

First *Nike-Hercules* inspection . . .

was made last week at the Douglas production plant at Charlotte, N.C. DOD has announced that both *Hercules* and *Bomarc* will be used as part of air defense of the U.S., apparently putting to an end the hassle over the respective merits of the two systems and any decision of one missile being selected over the other. This is in line with the defense-in-depth concept, dictating the employment of both. *Hercules* kill radius—30 to 75 miles, *Bomarc* kill radius—100 to 250 miles. *Hercules,* according to AOMC's General Medaris, can handle any foreseeable air threat for the next five years.

North American forms . . .

new rocket development group at its Rocketdyne division for ARPA-ABMA clustered engine booster program. First work will be in connection with the H-1 satellite boost engine. The H-1 will use eight *Jupiter* engines clustered and manifolded into a single thrust unit developing 1.5 million pounds.

American Rocket Society . . .

Army Engineers and several missile industries have started a pioneering education program for space engineers and scientists of the future. The ARS National Capital Section in cooperation with the Army Engineers and missile industries has started a course for science teachers and students in the safe methods of high school education. Industry cooperation in the Capital area includes: Aerojet-General, Atlantic Research, Diversey Engineering, Melpar, Rocketdyne and Thiokol.

ARPA's look to the future . . .

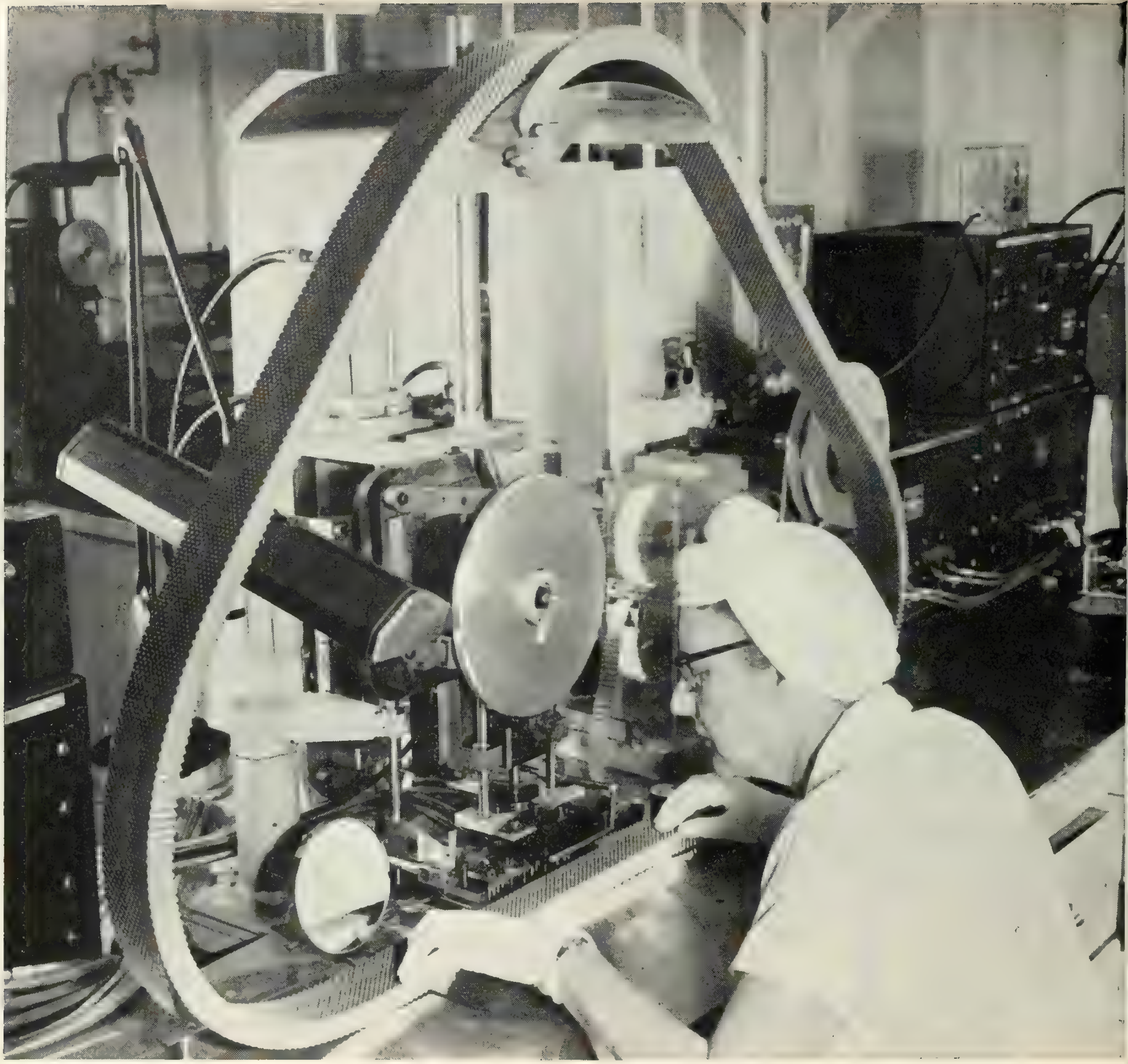
was further exemplified by its authorization to the Army, Navy and Air Force to negotiate major research contracts with four leading chemical companies for new chemicals in the solid propellant field. The firms are Dow Chemical, Esso Research and Engineering, Minnesota Mining & Manufacture and American Cyanamid. ARPA told m/r that this is not a propellant improvement program but an effort to move into an entirely new realm of solid development by searching for untried chemical formulations. Current solids use off-the-shelf chemicals that have been researched to the near maximum in an effort to increase their power output.

Research contracts target date . . .

is December 1, when $4 to $8 million will be awarded to the four selected companies at unit values of $1 to $2 million each. Thirty firms submitted bids in long range programs with ARPA selecting from eight. The contracts will call for out-of-the-lab small scale static testing.

Contracting procedures . . .

of the National Aeronautics and Space Administration will be handled in accordance with the Armed Services Procurement Act. NASA will have a major procurement and contracting program and will continue to purchase those types of services, materials and equipment ordinarily associated with the work at the laboratories it acquired from NACA. NASA plans to advertise for competitive bids whenever the Space Administration's requirements can be clearly defined. Contract awards on a fixed price basis will be made to the lowest responsible bidder. Contracts will be negotiated by NASA with educational institutions and other non-profit organizations, and small business firms will be given the opportunity to participate in supplying NASA procurement needs to the maximum extent practicable.



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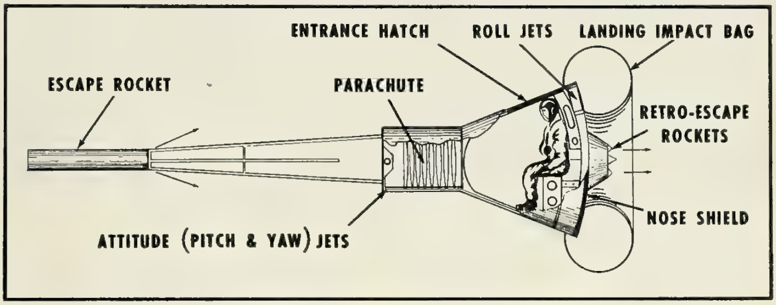
missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

A m/r Exclusive

Atlas Will Fire First Manned Satellite



NASA-ARPA Manned Satellite Concept

Specifications and flight program of the United States' first orbital manned satellite capsule which will be launched with an *Atlas-D* ICBM from Cape Canaveral have been learned by m/r. Details of the program were to have been given November 7 at Langley Field, Va., to 30 competing contractors attending a National Aeronautics and Space Administration bidbers conference.

The unclassified specification prepared by NASA, with the assistance of the Advanced Research Projects Agency, outlines the technical design requirements for a manned satellite capsule to be used in initial research on manned space craft. It is concerned primarily with the psychological and biological aspects of the space environment and problems associated with the launch, orbiting and re-entry of manned vehicles.

At the close of the November 7 meeting, manufacturers were to be invited to draw up formalized specifications, progress schedules, and estimates of contractual costs based on the formalized specifications.

Target date for submitting bids has been set for December 4. The contract for the complete satellite capsule, including design, fabrication and/or procurement, integration, and installation of all components will be awarded to the successful bidder within months, possibly after the first of the year.

• **Primary mission**—All the missions planned would be designed with a capability of accomplishment with or without a human occupant. First flights are expected to be with dummy payloads for evaluation of the launch safety factors of the mission. Later, appropriate animals will be sent aloft to determine biological reactions.

The capsules will be launched into semipermanent orbits and returned to the earth at a predesignated time and position with retro-rockets and aerodynamic drag. For the first orbital missions, two complete orbits are desired, although an arbitrary 18 cycles is considered possible. The vehicle will be equipped to stay in orbit for a maximum of 28 hours.

The capsule is to be designed (see illustration) to replace the nose cone of an *Atlas-D* (operation) ICBM with a minimum of modifications. The *Atlas* booster will be a standard weapon vehicle with no modifications in the propulsion system. An escape rocket mounted on the forward end of the capsule structure and designed to fire aft would lift the package free of the booster in case of failure. Retro rockets located on the base of the capsule for decay of re-entry velocity and *Atlas* nose cone separation rockets could assist the escape separation if deemed necessary.

Attitude (pitch and yaw) and roll jets will position the capsule for proper re-entry. The satellite passenger will be traveling forward during the accelerating phase of the flight and in a rear-

(Continued on page 16)

U.S. Mobilizes Foreign Brains

by E. E. Halmos, Jr.

Despite criticism from the home front and abroad, the United States has done—and is doing—a great deal about mobilizing the brainpower of the free world for defense. At this moment, for example:

Several hundred European scientists, working under some 350 contracts, are pushing ahead investigations of pure scientific phases of space operations.

More than $40 million is invested in assistance to seven European nations to aid them in development of missiles and military hardware.

Information of highly technical—and often classified—nature is being exchanged daily.

And, although the net gain is a very difficult thing to evaluate, military men in charge of the programs are certain that the U.S. is getting somewhere in the neighborhood of five times its money's worth out of the program.

Amid the vast and confusing complex of agreements under which the U.S. has undertaken to aid its allies and protect itself since World War II, it is not surprising that the very real work on scientific subjects and on modern weaponry has been obscured in recent years.

A foreign scientist, working under a $2,000 grant in some foreign university on a subject such as mathematical formulas that will explain certain aspects of gas dynamics, does not make a spectacular subject on which a politician can base a public-winning speech.

But in the current context of an almost desperate search for scientific know-how with which to bolster defense of the free world, it is of major importance that industries in the U.S. which support missiles are made thoroughly aware of what is being done, and how.

• **Where and how**—With particular reference to missile work, the effort to mobilize foreign brainpower falls into two categories:

1—Matters of direct military application, administered by the Defense

(Continued on page 14)

. . . Mobilizing Brains

Department's four-year-old Mutual Weapons Development program headquartered at Paris;

2—Work in the fields of pure science being conducted under direct supervision of Air Force and Army R&D teams, working out of central offices in Brussels. (The Navy also has R&D teams at work in the latter field, but most of the investigations under this program are concerned with purely nautical matters.)

The MWD program, set up under a provision of the 1953 Mutual Security Act, has had funds of up to $50 million within one year for its programs. The special R&D activities of Army and Air Force have in fact no money of their own—they act, in effect, as brokers of scientific research between European sources and U.S. agencies which supply funds.

Neither program is buying any actual hardware. The MWD group aids the R&D agencies of a foreign country (through government-to-government agreements) to develop missiles or missile components that can best add to the defensive capabilities of the country concerned.

In return for its monetary and technical aid, the U.S. also gets "first refusal" on the weapon or component, and complete information on its development including theory. Other allied nations have access to the weapons and the data as well.

• **Results**—Under the MWD program, the United States is bound by its agreements to observe classifications on information imposed on the project by the country doing the development. Thus if France, for example, determines that some of its work is "top secret," U.S. authorities may not release information on this work to other than authorized recipients. It is thus difficult to designate specific results.

However, one example of the MWD projects is France's wire-guided anti-tank missile, the SS-11, which can be fired from its container, from a vehicle, a helicopter or an airplane, and is guided by a "joy stick" control to its target. This missile is now being made available to free-world countries by France.

Another yardstick of the MWD work can be obtained through figures:

From 1954, when the program started, through June of 1958, a total of $385,864,739 had been spent by the U.S. and seven nations (France, Western Germany, United Kingdom, Norway, Belgium, Italy and The Netherlands) on MWD projects. Of this amount, the U.S. supplied $156.7 million, the "countries of origin" contributed $229.3 million.

ARDC and Army R&D programs are even harder to measure by material results, since their objective is most often pure research information. But at the moment, the two services have more than 350 individual contracts in force with individuals and universities abroad, averaging perhaps $3 million or more per year.

• **Teams represent services**—The Mutual Weapons Development program is administered by the Assistant Secretary of Defense for Research and Engineering and the Assistant Secretary of Defense for International Security Affairs. The program's field work is carried on through the MDW teams headquartered in Paris.

These teams represent the three military services, operating out of the office of the defense advisor to the U.S. Ambassador to NATO, under government-to-government agreements.

The MWD teams annually screen proposals submitted by the participating countries and recommend certain of these proposals. These recommendations are in turn reviewed by the U.S. element of SHAPE (Supreme Headquarters, Allied Powers in Europe); reviewed again by technical staffs of the military departments; and still again by a steering group composed of outstanding civilians and consultants familiar with the problems confronting the U.S. in providing assistance to its allies.

Top Brains at Work For U.S. and Free World

Some of the free world's most famous scientists are now at work for the U.S. and its allies, gathering scientific information applicable to problems of space flight and missilery.

Working for Air Force ARDC, under a total of some 270 current contracts, are such top names as these:

Prof. G. Bianchi, University of Modena, Italy.

Dr. Stig Sunner, University of Lund, Sweden.

Prof. W. Tollmien, University of Gottingen, Germany.

Prof. Toraldo di Francia, University of Florence, Italy.

Prof. I. Prigogine, University of Brussels, Belgium.

Dr. Marcel Levy, the Sorbonne, Paris.

Prof. Beat Hahn, University of Fribourg, Switzerland.

Prof. Kai Sigbahn, University of Upsala, Sweden.

Prof. Pol Swings, University of Liege, Belgium.

Prof. S. Gorodotzky, University of Strasbourg, France.

When this review has been completed, and projects are selected in accordance with budgetary requirements, the individual countries are given a go-ahead for development work during a stated period of time. U.S. technical specialists and information are made available, and the teams monitor progress of the programs.

The R&D work is administered directly by the Army and Air Force, with small highly trained technical groups headquartered in Brussels.

These groups work on an entirely different basis. The officers—out of uniform—attend scientific meetings and otherwise mingle with the European scientific community, seeking out men and work that may be of interest. The area in which these groups work is again not limited to NATO countries.

• **Working operation**—Contact is established with a European scientist who has an interesting investigation to report or underway. In a series of personal visits and communication, U.S. specialists determine that the project may be of value. The scientist is then asked to submit a brief proposal outlining his work and the results he expects to achieve, along with probable costs and time involved.

Since the R&D teams have no money of their own, these proposals are reviewed and passed on to appropriate agencies in the U.S. that have money for such work—such as the Air Force's Cambridge (Mass.) center. Scientists there evaluate the proposal further, and, if approved, pass on to the R&D team the authority to contract for the work at a specified amount.

U.S. officials say the results have been amazing from a cost viewpoint. European universities can undertake work of this kind at anywhere from a third to a fifth of the cost of similar work in the U.S.

Some of the projects now under way include: basic research in metal corrosion, at the University of Modena, Italy, for one year, cost $8,500; thermochemistry of selected radical recombinations, at the University of Lund, Sweden, two years, cost $22,500; interaction of sound and turbulence, at the University of Gottingen, Germany, one year, cost $3,000.

The results of these investigations are first made available to the agency paying for them; then are circularized to interested U.S. industry and then made available through ASTIA.

input devices

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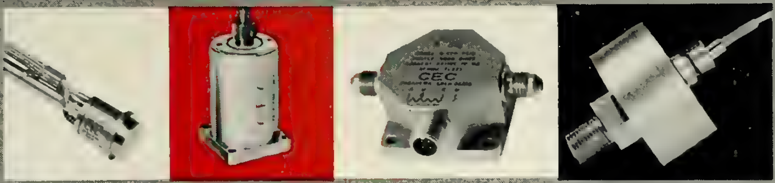

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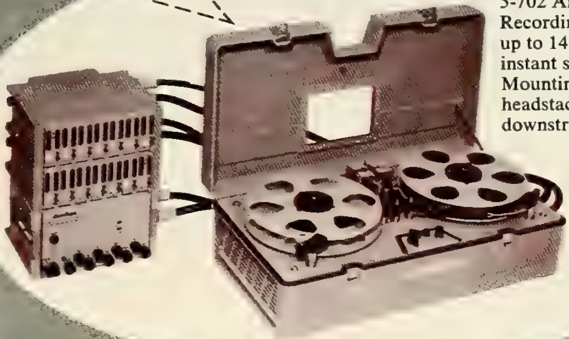
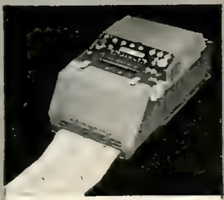


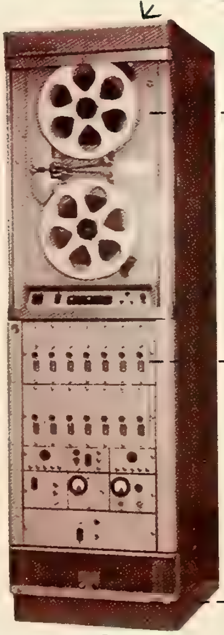
readout devices

MULTI-CHANNEL OSCILLOGRAPHS AND DIRECT-WRITING DATARITE MAGAZINES



CATHODE-RAY RECORDING OSCILLOGRAPHS

MILLISADIC HIGH-SPEED DIGITAL DATA PROCESSING SYSTEMS



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. . . Atlas for Satellite

ward-facing position during the re-entry deceleration phase. A heavy metal shield (at the passenger's back) will absorb or radiate the aerodynamic heat of re-entry. After the velocity has been sufficiently diminished, the shield will be ejected, parachutes will be forced into the slipstream, and a rubber landing bag will be inflated.

Launch will be from Cape Canaveral with direction of orbit initiation from 30 degrees north or south of east. The first flights for testing the components will be over the instrumented range to Ascension Island. Inhabited flights will be launched in a direction most suitable for an optimum recovery range.

The manned capsule, including the escape system components, has an effective launch weight target value of 2,400 pounds. Actual capsule weight that will be projected into orbit will be about 2,000 pounds. The escape system, consisting mainly of a forward thrust rocket and supporting framework, will be ejected after separation of the *Atlas* nose cone instrumentation section from the booster section. An extremely rigid orbit altitude requirement will demand precise power control and guidance. Orbit will be almost completely circular with an apogee of 120 nautical miles and a perigee of 110 nautical miles. This will require an eccentricity of no greater than five thousandths (0.005).

- **Recovery**—Initiation of the re-entry maneuver will take place at a point calculated to bring the capsule to an impact point as near the launching station as possible. In an emergency, the re-entry can be started at any point in the orbit. This is the reason for the critical tolerances in orbit altitude requirements.

Once the capsule is in orbit and approximately parallel with the earth's surface, the attitude jets will be activated to bring the payload into correct position for re-entry. Up until this time the passenger has been facing forward with the metal re-entry shield at his back. As the pitch jets flip the capsule over the roll jets rotate the vehicle in order to keep the passenger in an upright position.

When the manned vehicle has decelerated to a velocity of Mach 1, a drogue parachute will be deployed to provide additional dynamic stability. Provisions will be made for the inclusion of two landing parachutes in the case of failure of one. The first parachute will be deployed at an altitude high enough to allow time for the deployment of the second if necessary. Sinking speed will be 30 feet per second with a theoretical impact altitude of 5,000 feet.

Although it is planned to attempt recovery over water, the capsule will, in addition to its buoyant and water-stable characteristics, be designed for maximum protection from serious injury under conditions of land impact.

The vehicle will contain sufficient power and supplies to sustain the occupant and the recovery system for 12 hours after landing. Total internal operational capability—40 hours.

- **Design checkout**—Several checkout missions will be conducted prior to the first manned flight. Capsules, loaded with equipment and telemetry instrumentation, and later with monkeys aboard will be fired over the Cape Canaveral range for entry and recovery simulation. Accelerations and decelerations will be the same as those that will be experienced during the later space flight phase of the program. Acceleration and deceleration will not exceed nine "gs" (*Atlas* operates at less than this). This may be similar to Army's *Project Adam* proposal (m/r, June, 1958, p. 40).

The entry and recovery phases of the checkout flights will be carried out in the same manner as the orbiting flights. Until the *Atlas* is available for the flight simulation program the *Thor* or *Jupiter* IRBMs might be put into service.

- **Escape system**—Maximum emphasis will be placed on the safety of the passenger. An automatic payload separation and ejection system will be active until five seconds after the *Atlas* booster burnout. The system will stop the flow of propellants to the engines (either booster and/or sustainer, depending upon phase of burning) and a solid propellant escape rocket will be fired to separate the capsule from the *Atlas*.

If escape is necessary after the booster engines have burned out and the sustainer is still firing, the *Atlas* nose cone separation rockets will be fired to push the capsule farther from the booster. The retro-rocket system can also be fired to give an additional velocity increment.

The escape rocket system will provide enough thrust to accelerate the payload 250 feet during the first second at pad-phase of launch and to a maximum altitude greater than 2,500 feet from ground zero. From X minus zero to the burnout of the booster engines (approximately 160 seconds) the capsule must also accelerate to a minimum lateral velocity of 30 feet per second during the first second to carry it away from the path of the booster system. An automatic monitoring system for detecting unsafe conditions during launch and for aborting the booster is receiving top priority.

Missile Investments Boosted in Chicago

Stocks of missile companies recently received major attention at the Mutual Fund Convention in Chicago. Missiles-Jets & Automation Fund, which specializes in such securities, presented a program featuring astronautical scientists and had an exhibit of missiles. Some 1,000 mutual fund specialists attended the convention.

The Fund was described to the delegates as the first of its kind organized—not by Wall Street—but by men active in astronautics technology. Dr. Theodore von Karman, chairman of AGARD, is chairman of the Board, and Andrew G. Haley, president of the International Astronautical Federation, is president.

Dr. Wernher von Braun and three members of the technical advisory board, Dr. C. C. Furnas, Dr. Edwin R. Gilliland and Dr. Athelstan Spilhaus, were speakers.

Firms Bidding on NASA Satellite Capsule

The 30 firms invited to bid in the NASA-ARPA manned satellite capsule program, included:

Aeronutronics Systems, Glendale, Calif.; American Machine & Foundry Co., New York City; Avco Manufacturing Corp., Lawrence, Mass.; Bell Aircraft, Buffalo, N.Y.; Boeing Airplane Co., Seattle, Wash.; Chance Vought Aircraft, Dallas, Texas; Aerophysics Development Corp., Santa Barbara, Calif.; Convair, San Diego, Calif.; Cook Research Lab., Chicago, Ill.; Douglas Aircraft, Santa Monica, Calif.; All-American Engineering Company, Wilmington, Delaware; United Aircraft Corp., East Hartford, Conn.; Winzen Lab., Minneapolis, Minn.; Northrop Aircraft, Inc., Hawthorne, Calif.; Ramo-Wooldridge Corp., Los Angeles, Calif.; Republic Aviation Corp., Farmingdale, Long Island; Ryan Aeronautical Corp., San Diego, Calif.; Lear Inc., Santa Monica, Calif.; Allison Div., General Motors, Dayton, Ohio; Sperry Gyroscope Co., Great Neck, L.I.; Westinghouse Electric Corp., Washington, D.C.; Aero-Jet General, Azusa, Calif.; Fairchild Engine & Airplane Corp., Hagerstown, Maryland; General Electric Co., Philadelphia, Pa.; Goodyear Aircraft Corp., Akron, Ohio; Grumman Aircraft Engineering Corp., Bethpage, L.I.; Lockheed Aircraft Corp., Burbank, Calif.; Martin Co., Denver, Colo.; McDonnell Aircraft Corp., St. Louis, Mo.; North American Inc., Los Angeles, Calif.

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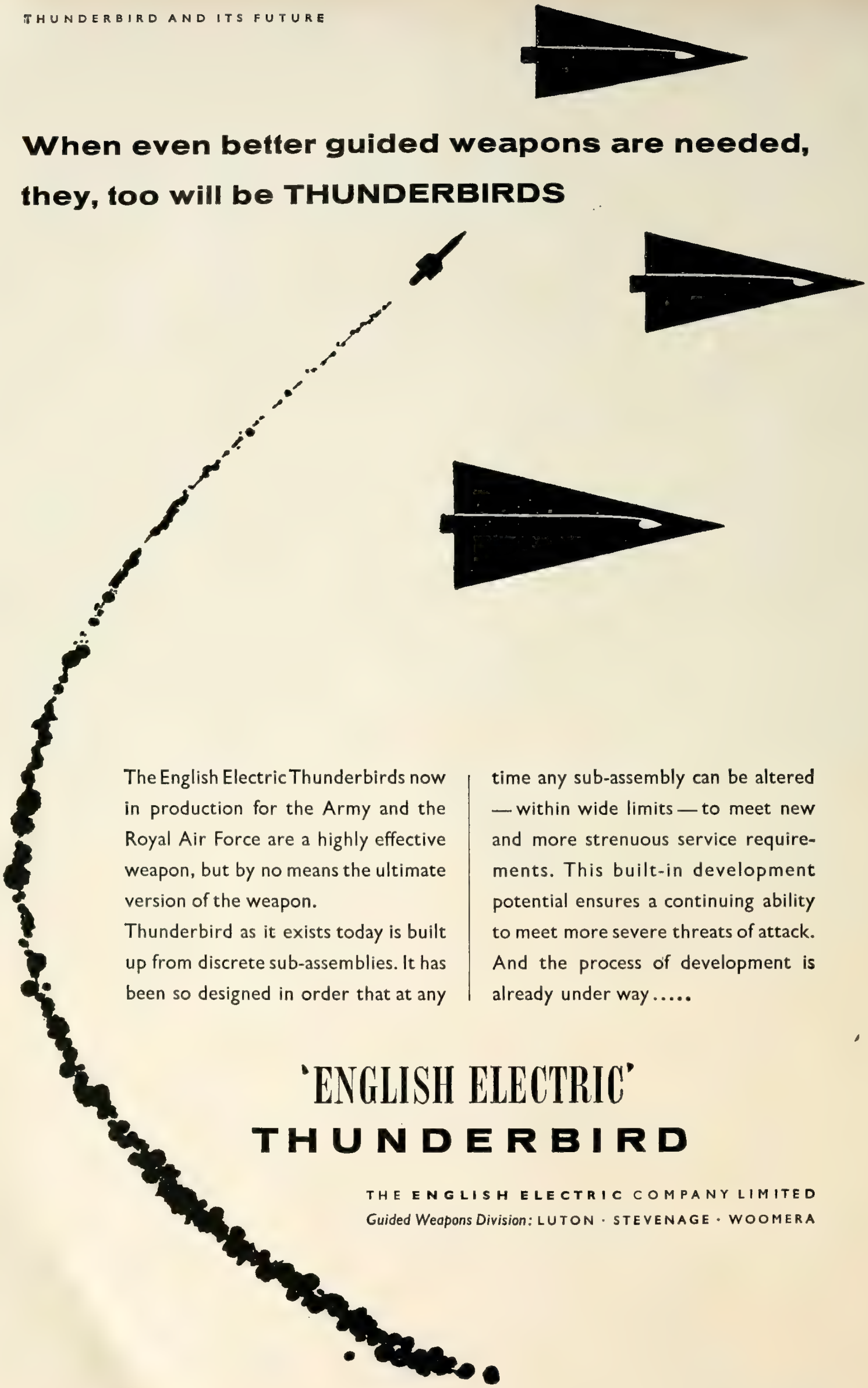

When even better guided weapons are needed, they, too will be THUNDERBIRDS

The English Electric Thunderbirds now in production for the Army and the Royal Air Force are a highly effective weapon, but by no means the ultimate version of the weapon.

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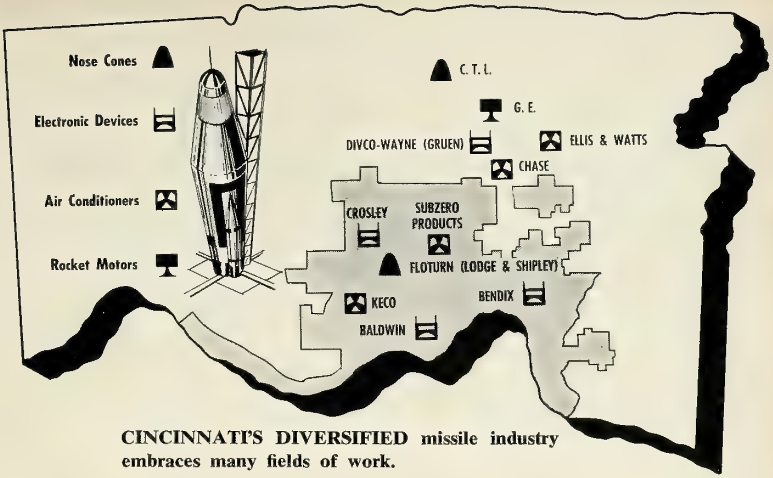


CINCINNATI'S DIVERSIFIED missile industry embraces many fields of work.

Cincinnati: Job Shop for Missile Industry

by John C. Smith
Special m/r Correspondent

Cincinnati—Diversification, long a Cincinnati watchword, has somewhat obscured the rise of the missile industry in the Cincinnati area. The area's contribution to the missile business is kept in the background by this diversification.

"Made in Cincinnati" appears on very few products, but few products are made that do not contain parts made in Cincinnati or produced on Cincinnati-made machinery. Here's why:

Area industry occupies a strong secondary position in the missile age. Relatively few "end products" are produced. Mostly, it is supporting elements for other industries and products. A big job shop, in other words. But the supporting role is of an essential nature to the missile business. Scope of activity can best be described by the industries themselves. Here's what they are doing:

• General Electric

Rocket motors and jet engines are made at General Electric's plant in Evendale. GE built the X-405 rocket motor for the *Vanguard* first stage and is building the *Regulus II* J-79, plus power for the F-104 and the B-58. The J-93, reportedly a "chemical" jet engine, is under development.

A "stretch-out" in defense orders caused layoffs, trimming the plant force at Evendale to 14,000 at the start of 1958. But employment has climbed to 15,000. Recently, the Aircraft Nuclear Propulsion Department received $3.8 million from the AEC to increase and improve equipment. Some viewed this as a hint that a production-type atom engine may be near. Operating expense for the AEC at Evendale for fiscal 1959 was reported to be $45.7 million.

In June, transfer of the Electric-Auto-Lite buildings adjacent to GE boosted floor space to five million square feet and acreage to 405. This is part of the three-year, $500 million expansion plan now in its third year. The Auto-Lite complex added 14 buildings, 135 acres and three million square feet of floor space. Price, around $15 million. The weekly payroll now is $1.5 million.

• Avco-Crosley

The Crosley Division of Avco Manufacturing Corp., with headquarters in a plant in Evendale too, makes an interesting study in change. During World War II Crosley was pretty well taken up with war work. In 1946, Avco made Crosley a full operating division and the company went into the appliance and television fields. Then in 1956, Crosley almost entirely withdrew from appliances to intensify defense work. Until recently, defense work was about 70%. Now Crosley is moving the other way again, trying for a 50-50 basis.

Crosley's Nashville plant produces airframe components and soon will produce a new stainless steel honeycomb sandwich, called Avcomb, which will be useful for missiles. It reportedly has the strength of solid steel at tenth the weight and can take air friction temperatures up to 600 degrees F.

Crosley's Richmond Division makes stabilizer assemblies for the Hughes *Falcon* and metal shipping containers for the missile. Other parts that have been manufactured at Richmond include rudder drives for the *Redstone*, *Jupiter* and a major part for the *Sergeant*.

The Arlington Street Plant in Cincinnati is manufacturing a command receiver unit capable of command and destruct. Crosley long has been associated with fuzing in the missile and rocket field and has worked with the Navy in developing fire bombs.

In July, Crosley received a contract for mobile radar, worth $5 million. This, and a *Polaris* electronics contract is pushing Crosley past the $50 million mark in 1958.

• Keco Industries

Largest of four Cincinnati area firms in the specialized refrigeration field, Keco Industries, Inc. supplies a unit to cool electronic equipment for the *Atlas* during pre-launch checkouts. The unit disconnects upon firing. With a volume of approximately $4 million a year, Keco employs 200 persons.

• Other Industries

Cincinnati Sub-Zero Products makes equipment for rivet storage, cold-stabilization of metals, expansion fitting and environmental testing.

Ellis & Watts Inc. provides cooling for electronics in mobile vans, dry air for pressurized radar wave guides and temperature stability for radomes to abet radar accuracy. It has 80 employees; a 22,000-square-foot factory, and a volume of $1 million last year.

Chase Industrial Refrigeration Equipment & Engineering Co. is mostly in aircraft ground cooling units. Navy is its big customer. The units are mobile trailers designed to supply cooling for aircraft electronics during check-out on the ground.

• Cincinnati Testing Labs

Cincinnati Testing & Research Laboratories (CTL) developed the nose cones used in *Jupiter* tests this summer through its "Floturning" process; a method of cold-working metal. It was used also to form the nose cones for *Explorer* satellites.

CTL is working on the re-entry body for *Polaris*. A preliminary contract was reported at approximately $500,000. The company was founded in 1946 as an independent testing laboratory for high temperature and structural plastics. Test equipment and facilities for limited production are housed in a 21,000-square-foot structure.

The company is an illustration of local boys making good. The founders are Elmer P. Warnken, president; and Melvin N. Korelitz, vice president and treasurer, both chemical engineers. CTL has 75 employees and holds 11 patents in plastics rotor and stator blades for jet engines. Other products include rocket nozzles for the third stage *Vanguard* rocket, blast tubes for *Talos* and *Terrier* missile and parts for *Juno II*.

NOSE CONE for *Explorer* is product of Cincinnati Testing Labs. "Floturning" is the process.

• Formica Corp.

Formica Corp., subsidiary of the American Cynamid Co., known for burn-resistant laminated plastic table and counter tops and surfacing material for homes and business, produces bases for printed circuits widely used in the electronics industry. Formica's copper clad laminated plastic cards are used in the miniaturized circuits of the *Vanguard* satellite.

Another grade, FF-89 for printed circuits, can be "rolled up and tucked away in a corner." Modified Formica FF34 is used by the Temco Aircraft Corp., in the XKDT-1 *"Teal"* target drone. The laminate serves as a thermal barrier between the solid propellant motor and the motor case and also is insulating material in the rocket motor's blast tube.

The Formica liner is bonded to aluminum walls. Perforating the walls along with an exhaust system cancel shock waves that otherwise would be formed. During tests, wall shock waves would reflect on the test object, giving erroneous results. ARO chose the Formica as back-up for the liner because of its high machinability, light weight and ability to dampen noise and vibration. The closed-circuit wind tunnel tests aircraft and missile propulsion systems mounted as they would be in flight. It can also be used for testing full-scale models.

• Divco-Wayne Corp.

Electronics has some strange "bedfellows" in Cincinnati. Divco-Wayne Corp., manufacturer of special vehicles such as delivery trucks, recently entered the missile scene through purchase of the Electronics Division of Gruen Industries Inc. The new division probably will be known as Divco-Wayne Electronics, but the company is not yet settled on a name.

When with Gruen, the company was somewhat hampered by lack of capital and was forced to forego some contracts as a result, but Divco-Wayne capital should boost the capacity and yearly contract value should be doubled in 18 months. Present output is approximately $3 million a year.

D-W Electronics inherited some 200 employees, of whom 40 are engineers. Sale price was around $1.5 million. It became a Gruen division three years ago, having grown from within the company. It built electronic timers for the *MB-1* Genie with .002 seconds accuracy, and digital readouts and printers for the *Atlas*. Convair also gets gyro test tables and flight control tables from the former Gruen division.

• Baldwin Piano Co.

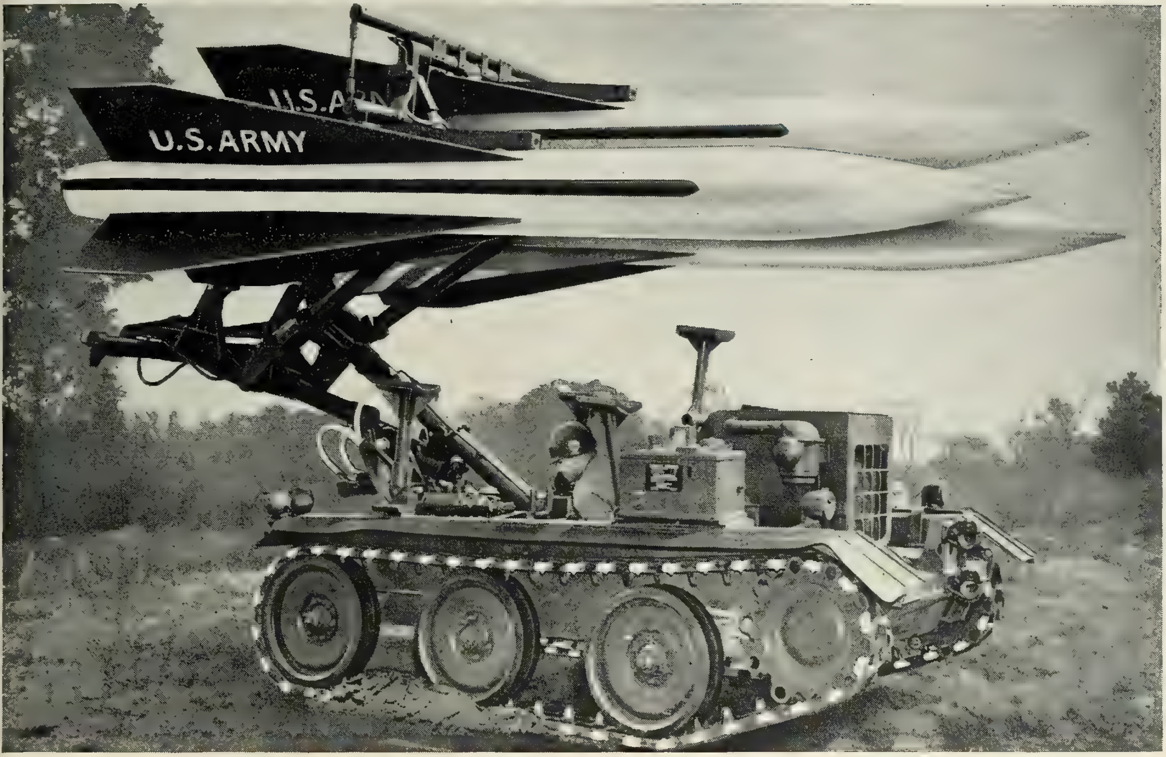
It is probable that Baldwin Piano Co. got into the missile and military electronics pie through its production of electronic organs. Last year Baldwin consolidated, selling its Ancor plant near Cincinnati and moving its work to the main plant near the downtown area. The approximate earnings for

PLAYING AN important part in Cincinnati's missile business is the Crosley Division of Avco Manufacturing Corp., active in *Polaris, Jupiter* and *Redstone* systems.

GENERAL ELECTRIC'S gigantic Evendale facility employs about 15,000 and has a three-year expansion program which will call for expenditure of $500 million.

...speaking of

Missile Ground Support ***MOBILITY***



U. S. ARMY PHOTO

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FMC has designed and produced more military-standardized tracked vehicles than any other company in America. So, when Northrop Aircraft, Inc., subcontractor to Raytheon Manufacturing Company on the Army's new HAWK weapon system, needed a rugged mobile transporter-erector, they came to FMC. The vehicle had to be capable of operating in rough terrain, powerful enough to transport three HAWK missiles, and light enough to be air lifted by helicopter. Northrop and FMC engineers worked out the design concept, FMC engineered and built the vehicle portion of the unit; and today this speedy carrier is in production at FMC as part of the Army's HAWK weapon system.

With more than 17 years' experience in the design and production of military equipment, FMC is prepared to handle your missile ground support equipment project — from concept to delivery — on schedule. *Consult FMC at the initial stage of project planning.* Contact us for more information.

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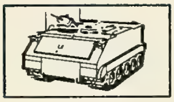
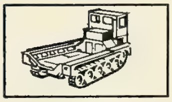
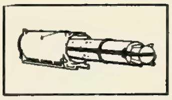


Multi-Purpose Vehicles

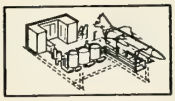


Prime Movers



Shipping & Storage Containers

Launcher-Erectors & Power Units



Propellant Handling Systems

Creative Engineers: Find stimulating challenge at FMC's Ordnance Division

Putting Ideas to Work

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Ordnance Division

Missile Equipment Section I-G

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1955 were $32.5 million. This figure dropped to near $28.7 million in 1956. Much of the difference was due to a drop-off in military contracts, it was reported.

The piano part of the company is 94 years old. Through electronic organs, leading to defense contracts, Baldwin has developed engineering experience in transistor and printed circuitry, miniaturization, analog-digital conversions, and precision photoelectric and optical assemblies.

In May, Baldwin bought A.R.T. Electronics Inc. of North Little Rock, Ark. The firm is in electronics research for government armament.

• Bendix

Bendix Aviation Corp.'s Cincinnati division handled cable assembly operations for the *Nike,* but now is largely concerned with development and manufacture of electronic test equipment. It recently marketed a telemetering instrument.

• Ohmart Corp.

The Ohmart Corp. entered the Cincinnati missile picture with its radiation level gauge.

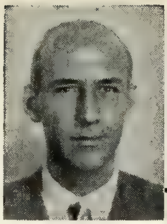
Ohmart developed a method of measuring liquid level in a tank which consists of a radiation source placed on one side of the tank with a cell on the other. The Ohmart cell produces an electric current in relation to the amount of radiation striking it. It does this directly, needing no ionization chamber.

In one application, as used at Redstone Arsenal, the gauge shows the LOX level in loading operations, Ohmart reports. There now are 700 installations in the country. The device also can determine the specific gravity of liquid flowing in a pipe. With this method, nothing has to be put inside the tank or pipe. It is all done from outside.

Int'l Conference Set For Science Information

An International Conference on Scientific Information, dealing with the problems of storage and retrieval of reports and other results of scientific investigation, will be held at the Mayflower Hotel, Washington, D. C., November 16-21.

The conference, comprised of representatives of more than a dozen countries, will be under the sponsorship of the National Academy of Sciences, National Research Council, National Science Foundation, and American Documentation Institute.



propulsion engineering

by Alfred J. Zaehringer

Computers will aid at least two propulsion areas. Arthur D. Little scientists figure advancements will aid in developing new, un-made plastics for fuel-binders and structures, and combustion rate and equilibrium calculations for new fuels and propellants. Both are now characterized by a high number of complex variables that are amenable to digital analysis. The "grass-hopper" method is used for multi-components, while "Monte Carlo" methods are used for high energy rocket fuels.

Electrical or plasma jet rocket may not be near. Rhodes and Bloxsom, Canoga Park, Calif. firm, has expanded air at temperatures of 9,000°K and pressures of 40,000 psi through a supersonic deLaval nozzle. Throat erosions are very severe with heat inputs near 2.5 million watts per square inch. Nozzle vaporization times, ranging from carbon to tungsten and molybdenum, are measured in milliseconds. Electrical spark gas discharges are used.

Ramjets may be superior to turbojets for many up-and-coming regimes of high-speed commercial aircraft. Within the tropopause, Israel Institute of Technology aero engineers favor ramjets from the standpoint of propulsive efficiency at speeds over Mach 3. Some of this years commercial jets will be able to hit near Mach 1.

Vernier rocket engines for Atlas use LOX-RP-1 propellant. Fuels are contained in separate tanks, though main turbo pump system also serves verniers. The gimbal-mounted verniers are squib-ignited and burn during entire flight. The double-walled engine is made of spun 4130 steel. Copper wire, helically brazed to the inner jacket, forms the fuel passage. Since the head end of the vernier engine sticks into the airstream, an asbestos loaded, phenolic/silicone plastic protects against aerodynamic heating. Engines put out constant thrust, but directions can be changed on demand.

Nitrogen tetroxide substitute for LOX has been under evaluation since 1947. Allied Chemical Corp. producers reveal that they have made tank car shipments to the rocket industry since April.

More LOX for Redstone. Linde will build an air-separation plant near Huntsville, Ala., that will also produce argon and nitrogen.

Lithium propellants may be in the works. Lithium Corp. of America has been consulting with an outside firm on high-energy fuel studies and may be ready to hook up with Astrodyne in lithium research. Whether the work will be concerned with lithium perchlorate oxidant or lithium fuels is not known. High costs have delayed lithium propellant use. The hydroxide, starting point for the perchlorate and possible fuel derivatives, for example, took a price hike and now sells for about $0.75 per pound. AEC controls on lithium stocks may be responsible. AEC contracts on lithium are scheduled to run out soon, which may make for a less restricvive lithium market.

Erosive burning of homogeneous solid propellants is related to the gas flow along the fizz zone. Studies made at the Aeronautical Institute of Brussels University indicate that turbulence in the fizz zone causes erosive burning.

Rocket fires caused by the accidental ignition of such fuels as alcohol, gasoline, furfuryl, or xylidine with nitric acid or LOX can be put out by carbon-bromine-fluorine compounds. The Air Force names two as extinguishers: $CBrF_3$ or CBr_2F_2.

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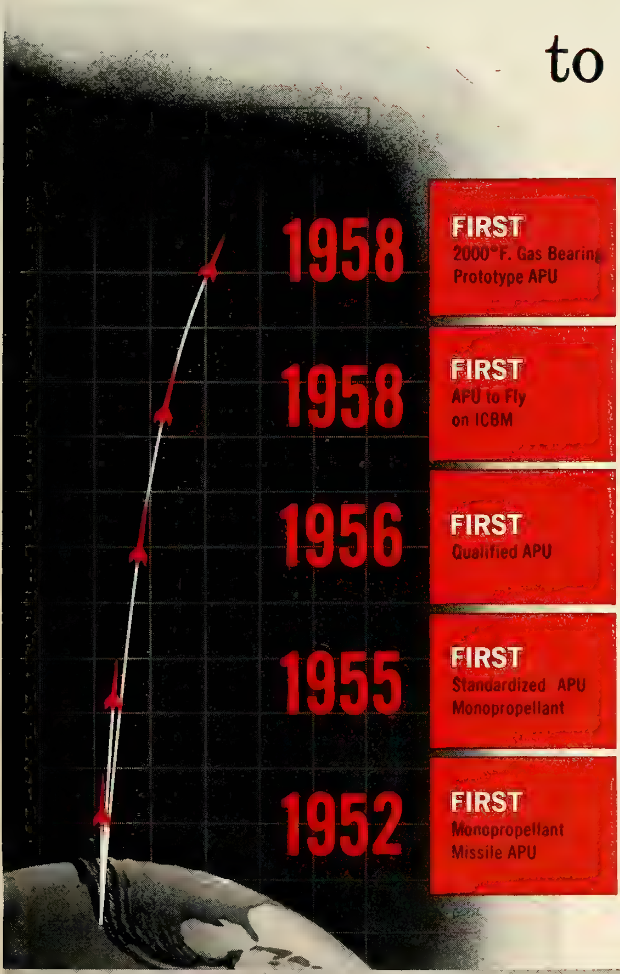
with **SECONDARY POWER...**

5 NOTABLE CONTRIBUTIONS

to missile flight...



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west coast industry

by Fred S. Hunter

A few weeks ago a major components manufacturer in the Los Angeles area wrote out a check for $1,000 to the Strategic Industries Association and became a sustaining member. This voluntary action was taken in appreciation of SIA's accomplishments in its campaign for better protection of proprietary rights in defense contracting.

SIA doesn't make a point of inviting sustaining memberships, but it has a few among larger companies who feel that the work this association of small, independent firms is doing is beneficial to the entire industry and therefore deserves support. Sustaining members have no voice in the actions or policies of the association, but SIA does make its reports and other information services available to them.

The SIA has come to be a rather remarkably effective trade group. One reason for this seems to be the rational and reasonable approach it takes in presenting its programs. It maps out its various projects with care, pursues them vigorously but without ostentation, takes its victories and its defeats in stride, and avoids trying to "fight city hall." Its work on the proprietary rights issue is a case in point.

A good many people have tried to do something about proprietary rights in military contracts, but without much success until SIA came along and succeeded in getting the defense department to consider revisions in that section of the Armed Services Procurement Regulations covering copyrights and data. SIA took the position that privately financed research and development for advanced defense materials requires the incentive of protection for the proprietary rights of the firms which originate new designs. The high complexities of missile design make this more important than ever.

SIA acknowledges that a fixed percentage of defense purchasing or defense subcontracting for small business firms is impractical, although in 1954, when the association was first formed under the name of Small Defense Industries Association, its members were of the opinion that a law fixing such percentages was just what they needed.

Another of SIA's basic policies puts it in conflict with another west coast group of small business firms in the defense field, the San Fernando Valley Small Plants Association. The latter organization is a strong advocate of advertised procurement. SIA favors competitive negotiated procurement, which it contends is a fair and effective means of obtaining the best buy for the government. Advertised bidding, it contends, paves the way to below-cost bids which may result in contract default, loss of time and dollars to government, and injury to contractors, the industry and the nation.

Like any trade group, SIA has some sore spots, such as the free use of government facilities. It has published a 40-page report carrying the title of "Government's Facility Fallacy" outlining its views on this subject in detail. But this is one area where, so far at least, it hasn't had much luck.

Industry roundup: Telecomputing Corp., Los Angeles, has received three additional contracts totalling $515,000 from Western Electric for production of gyros for Nike-Ajax . . . Big sales increase for Douglas Aircraft Co. For the nine months ending August 31, sales were $888,766,637 for net earnings of $16,546,190. These figures compared with $828,417,314 in sales and $24,710,406 in net earnings for the first three quarters of 1957.

when and where

NOVEMBER

School of Aviation Medicine, International Conference, Physics and Medicine of the Atmosphere and Space, Hilton Hotel, San Antonio, Texas, Nov. 10-12.

Society for Experimental Stress Analysis, 1958 Annual Meeting, Hotel Sheraton-Ten Eyck, Albany, N.Y., Nov. 12-14.

National Security Industrial Association and Air Research and Development Command, USAF, Symposium on Molecular Electronics, Washington, D. C., Nov. 13-14.

Conference on Scientific Information, AFOSR/Directorate of Research Communication, NAS, NSF and the American Documentation Institute, Mayflower Hotel, Washington, D. C., Nov. 16-21.

American Society for Quality Conference, Sixth Annual Aircraft and Missile Division Conference, Biltmore Hotel, Dayton, Ohio, Nov. 17-18.

American Rocket Society, 13th Annual Meeting and Astronautical Exposition, Hotel Statler, New York, N. Y., Nov. 17-21.

Eighth National Plastics Exposition, International Amphitheatre and Plastics Conference, Hotel Morrison, Chicago, Ill., Nov. 17-21.

Northeast Electronics Research and Engineering Meeting, Mechanics Hall, Boston, Mass., Nov. 19-20.

Lockheed Missile Systems Division's Research Laboratory, Third Symposium on Magnetohydrodynamics, Palo Alto, Calif., Attendance by invitation, Nov. 21-22.

The Convertible Aircraft Congress, designing and operating missiles from unprepared sites, Franklin Institute, Philadelphia, Penna., Nov. 28.

First Electronic Computer Exhibition and Symposium, Olympia, London, England, Nov. 28-Dec. 4.

DECEMBER

Third EIA Conference, Reliable Electrical Connections, Dallas, Texas, Dec. 2-4.

Mid-American Electronics Convention, sponsored by Kansas City Section, Institute of Radio Engineers, Municipal Auditorium Arena, Kansas City, Mo., Dec. 9-11.

American Astronautical Society, Fifth Annual Meeting, Hotel Statler, Washington, D. C., Meeting will be held in conjunction with the 125th Annual Meeting of the American Assn. for the Advancement of Science, Dec. 27-30.

160"

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On display this month at the A.R.S. Astronautical Exposition is a steel sheet *more than 13 feet wide,* ranging in gage from .082 to .088 inches. Produced on Lukens Steel Company's 206-inch mill, largest in the nation, the sheet was made by "pack rolling," a highly specialized method long used by Lukens in the production of its famous clad steels.

Lukens, producer of world's widest range of "head" shapes and sizes, has also produced domes of AstroSheet, and an example will be exhibited at the A.R.S. Show. For complete information on Lukens AstroSheet, call or write, Manager, Marketing Service, 271 Lukens Building, Lukens Steel Company, Coatesville, Pennsylvania.

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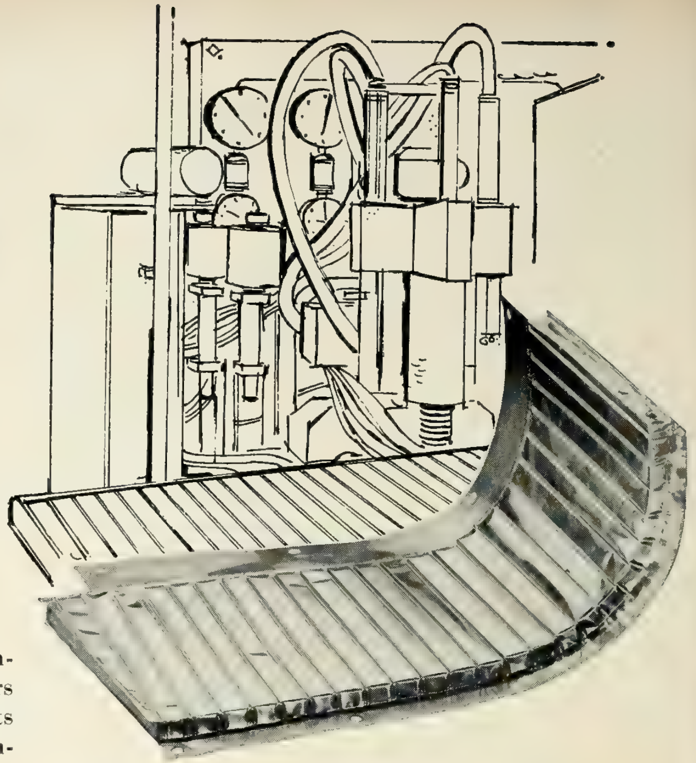

Leaders in the aircraft and rocket industries look to L·O·F Glass Fibers Company for the new developments in both thermal and acoustical insulating components, because this is the *only company in the glass fiber field* that performs all of the following:

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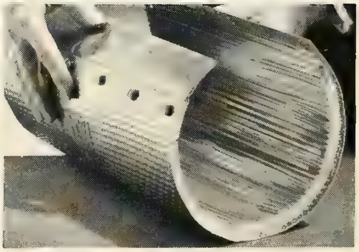
Insulation blanket made with ½ inch of Micro-Quartz felt withstands the searing heat of a 2000°F. flame.



Wrap-around blanket, encased in stainless steel, shields hot-air duct at 600°F. Insulation will not pack, settle or crumble.

New Micro-Foil tape, made from Micro-Quartz felt faced with aluminum, protects parts too small for molded or shaped insulation.

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Frangible Plastic Case Proven on *Nike* Booster

Epoxy Resins Aid In Reinforced Plastics

by C. L. Meeter*

SIXTY-INCH diameter tube demonstrates fabrication size possible with epoxy laminations.

Developed several years ago, the *Nike-Ajax* missile was one of the first successful surface-to-air weapons and is now paired with the *Hercules* as a major means of defense against attacks by high speed, high altitude jet aircraft.

When deployment of these missiles around major cities began a few years ago the public reacted adversely. In addition to worrying about accidental explosions of the missiles while on the ground, there was great concern about the impact of the heavy steel casings of the booster units.

To alleviate as much as possible the public's fears, a research and development program was undertaken to find a frangible booster—harmless to life and property. Many methods and materials were investigated before an epoxy resin laminate was given the go-ahead. However, not until recently has it been possible to discuss the use of reinforced epoxy resins for development of this frangible booster.

The booster is known officially as the T48E3 Self-Destroying *Nike-Ajax* Missile Jato, and was developed for the Department of the Army in conjunction with the Army Ordnance Corps. Fabrication of the Jato required performance characteristics never before achieved by reinforced plastics. This called for new materials, new processes, quality control techniques for the material and production standards and controls.

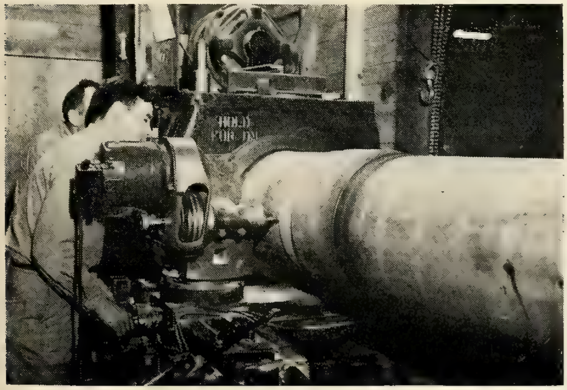
The Jato accelerates the missile to operational altitude and velocity and is then jettisoned. After separation from the missile, the Jato destroys itself at high altitude by the use of primacord explosive. The resulting non-lethal dust and small pieces descend to the ground at a low speed and low energy level.

The Jato is over 13 ft. long and 18 in. diameter, and consists of four major elements: the case, solid propellant fuel, stabilizing fins and explosive components to effect self-destruction.

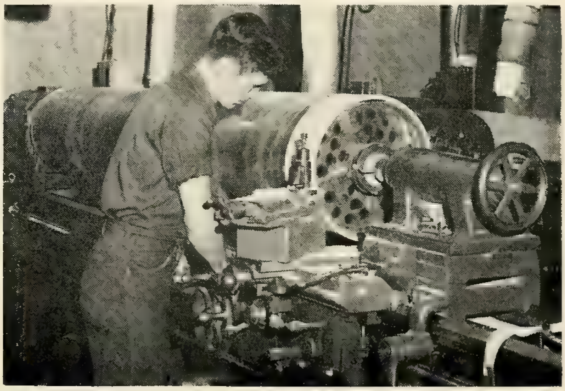
Parts of the Jato, constructed of the fiberglass reinforced epoxy resins, consists of the cylindrical case; main chamber; forward sleeve, which retains the thrust bulkhead and serves as the socket to engage the missile; rear sleeve, which retains the nozzle and provides sockets for support of the three stabilizing fins; adapter ring; head plate; igniter and springs.

In designing the reinforced epoxy Jato, the basic requirement demanded equal weight and performance in comparison to the standard unit which was constructed of high strength, heat-treated steel. Since self-destruction features consisting of explosives and their encasing shrouds had to be incorporated in the Jato, the basic booster had to be 20% lighter than a steel unit.

- **Weight major factor**—A square foot of 1/8 in. fiberglass reinforced laminate weighs about one pound—a steel plate of the same thickness would

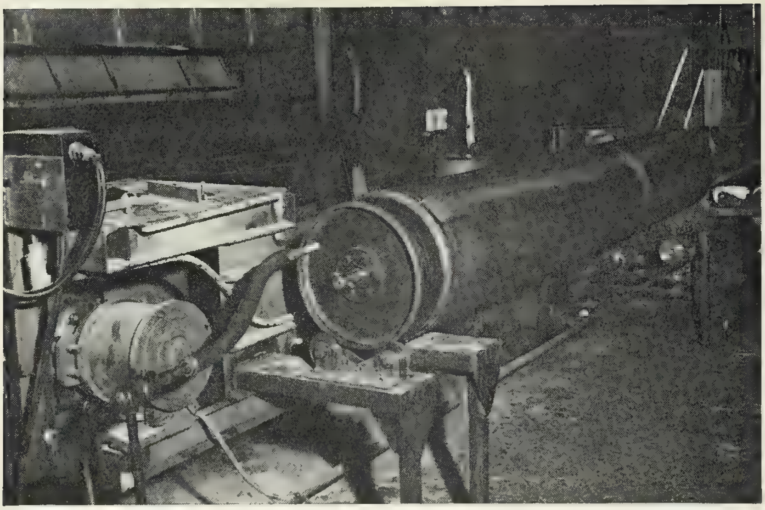


ASSEMBLED epoxy laminated *Nike-Ajax* booster is secured in jug chuck for drilling access holes.

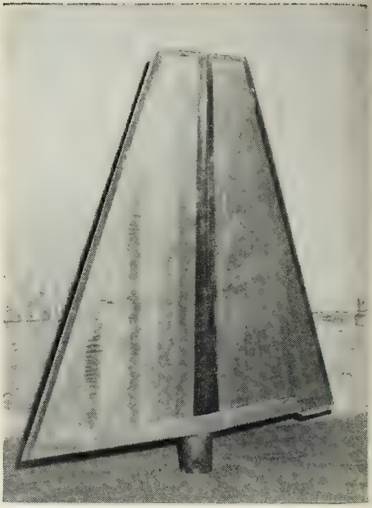


HIGH STRENGTH of the reinforced epoxy lamination simplifies thread cutting in main chamber.

Vice President—Plastics Division, Universal Moulded Products Corp. Bristol, Virginia



CURING laminated booster case after glass cloth has been wound on mandrel.



FIBERGLASS fin over foam core.

weigh about 4.3 lbs. per sq. ft. However, a tensile strength of 75,000 lbs. per sq. in. in such a laminate is a reality. The comparative strength for the same weight in steel would be 325,000 lbs. per sq. in., a feat not technologically possible at the present time.

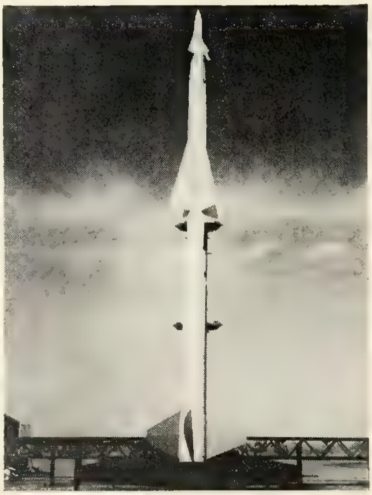
While the strength-to-weight advantage is of course necessary for further missile developments, epoxy resins possess other advantages worthy of note—they are non-corrosive, electrically non-conductive and heat resistant. Such reinforced plastics offer both load-carrying and thermal insulating properties at the same time. They also permit the close control of weight and dimensions with a precision unobtainable with metals. Where complex configurations are required, they are economical to produce.

• **Epoxy laminate advantages**—Actually, the major achievements in reinforced plastic construction for missiles were realized only with the use of epoxy resins. It was then possible to obtain the high shear strengths, particularly interlaminar shear strength, that made it possible to cut threads that would not peel, and also to tap holes in the laminates.

The basic difference between the epoxies and other resins such as the polyesters is the superior wetting of glass fibres obtainable with the epoxies. This enabled the achievement of higher strengths—tensiles up to 20%, flexurals up to 20%, and compressive strength up to 50%. The interlaminar shear strength between fiberglass plies is at least three times greater.

When investigations begun in 1953 revealed that the epoxies would improve the interlaminar shear, Epon 828 was selected. Later the switch was made to Epon 820 because of its lower viscosity. Both curing agents Z and D have been used—Z to achieve higher strengths at elevated temperatures, and D where such requirements are not so critical.

• **Cloth buildup**—The majority of parts for the reinforced epoxy booster were fabricated by convolutely winding glass cloth on a mandrel, the cloth being impregnated with the Epon resin formulation as it was being wound onto the mandrel.



NIKE-AJAX with frangible booster.

These parts included the main cylindrical section of the Jato, the forward and aft sleeves, the forward missile-to-booster adapter which is part of the forward sleeve, and the retaining springs which hold the propellant aft.

The head plate, igniter plug and the thrust bulkhead which is located inside the missile tube booster adapter were made up of woven roving and resin molded under pressure to form a laminate. The main parts of the stabilizing fins, such as the spars and skins, consisted of fiberglass laminations over a cellulose acetate foam core.

Self-destruction of the chamber is accomplished through an external wrap of primacord, while destruction of the heavier internal structural components and fins is achieved by internal containers of primacord.

The work on the *Nike-Ajax* booster is the beginning of engineering progress in using fiberglass reinforced epoxy laminates in ordnance applications. This booster was just a small one. Development is now underway on a much larger booster (more than twice the size) where solid propellants will be used. In the future, greater developments are anticipated inasmuch as considerable weight can be saved in missiles in comparison with metal construction.

Big magnesium and aluminum extrusions produced from Dow's 13,200 ton press

A whole new range of king-size dimensions is now available for design engineers. Dow's new 13,200 ton extrusion press at Madison, Illinois, is producing "special" sizes for quick delivery. These projects include work for aircraft and missiles, automotive, building, and highway construction.

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Integrated Package A Must for Antennas

All antenna components should be matched to eliminate discontinuity and power loss

by Raymond M. Nolan

In these days of design competitions to determine the complete weapons system requirements before any hardware is begun, there is real opportunity to bundle all of the antenna requirements into an integrated radiating package.

This means, along with the systems engineering required, that antenna manufacture could be taken out of the metalworking shop and assigned to qualified radiation systems specialists for development and production.

For it is becoming increasingly important that all components, from the transmitter out, and from the antennas back to the receiver or transceiver, be matched to eliminate or cut down on discontinuity and power loss, while at the same time assuring maximum pattern coverage with lowest VSWR.

Today, all missiles, including test versions of the big ballistic birds, have to depend on some sort of radiated intelligence, either active or passive, to accomplish their mission.

Common practice is to stick one antenna after another on a missile as various types of equipment are added for guidance, monitoring, telemetering or command signals. This frequently leads to test versions of missiles that have a resemblance to an hors d'ouvre with toothpicks sticking out all over.

• **Integrated approach**—But at least one company is taking a systems approach to the radiation problem and is delevoping its products as an integrated package. The firm is the Electronic Specialty Company of Los Angeles. According to C. Raymond Harmon, assistant to the president, the emergence of this type of thinking was brought about largely by customer demand.

"People were getting tired of specifying a whole range of antennas and associated switching and matching units with no attempt to look at the possible cumulative losses that were building up throughout. So we've been asked frequently to come up with systems that could be purchased by a customer under one part number, specifying only the db gain or loss and allowable VSWR. This is what we are presently doing in many of our programs and we hope this will be the forerunner of a trend wherever radiating systems are used," Harmon said.

Harmon pointed out that since the majority of missile-borne equipment in use today required broad band applications, experience showed that, even using completely impractical close tolerance component specifications (which would result in excessive costs), the discontinuities and mismatches occurring often add in one frequency range and subtract in another.

Discontinuities, he said, are very often the result of such simple things as incompatible connector and cable assemblies and can only be eliminated by the practice of matching each and every component, one to the other.

Electronic Specialty Co. recognized the vulnerability of existing procurement practices and for several years has been working with Wright Air Development Center and the Bureau of Aeronautics on system procurements. Part of the task was to convince systems planners that the only possibility of developing the optimum communication system is a truly matched radiating system purchased under a single specification, defining the total capabilities of all the components.

ANTENNA SYSTEM on missile model being checked at Electronic Specialty Co.'s test facility.

The overall system checkout procedure is another element which should also be included in the system specification. The specification then fixes the overall performance in which the efficiency is measured with a system mock up similar to the installation in the missile.

Harmon feels that the era of individual component manufacture or procurement with complete disregard for its end use in sophisticated systems is rapidly coming to an end.

He adds that it is becoming absolutely necessary that a true radiating system contractor have the capability to study the complete problem, including: the location studies in conjunction with the manufacturer of the flight vehicle, the bands to be used for most efficient pattern coverage, minimum interruption of structures by the use of multiple arrays, and the choice of dual antennas with multiplexing and power dividing.

As a sequel to the system study, the radiation specialist must have the capability to develop the required component and microwave assemblies, including such items as filters, power dividers, diplexers, matching networks, cabling assemblies, and switches.

• **Important criteria**—Electronic Specialty Co. admits that with so many antenna requirements, some sort of compromise is almost always involved. The company says the following criteria are important in evaluation of the antenna system:

1. **Aerodynamic**—Obviously, the missile cannot come out looking like

a porcupine. As many antennas as possible must be made flush, combined with other needs, faired into existing structure, or be designed of proper fineness ratio.

2. **Structural**—As antennas are built flush, openings in the skin must be evaluated for stress, under static, dynamic and heating conditions. Radome and cover plate materials must be developed.

3. **Omni pattern**—The most difficult pattern to achieve is that of omni directional coverage, and this is often a requirement for certain systems to insure full operational flexibility. Usually there is only a single optimum area for the omni antenna, and this single antenna must be diplexed to several uses.

4. **Voltage breakdown**—At high altitudes, and in high power circuits, voltage breakdown is a very critical consideration for all antenna system components. With a suitable low standing wave ratio, a greater power handling capability is achieved.

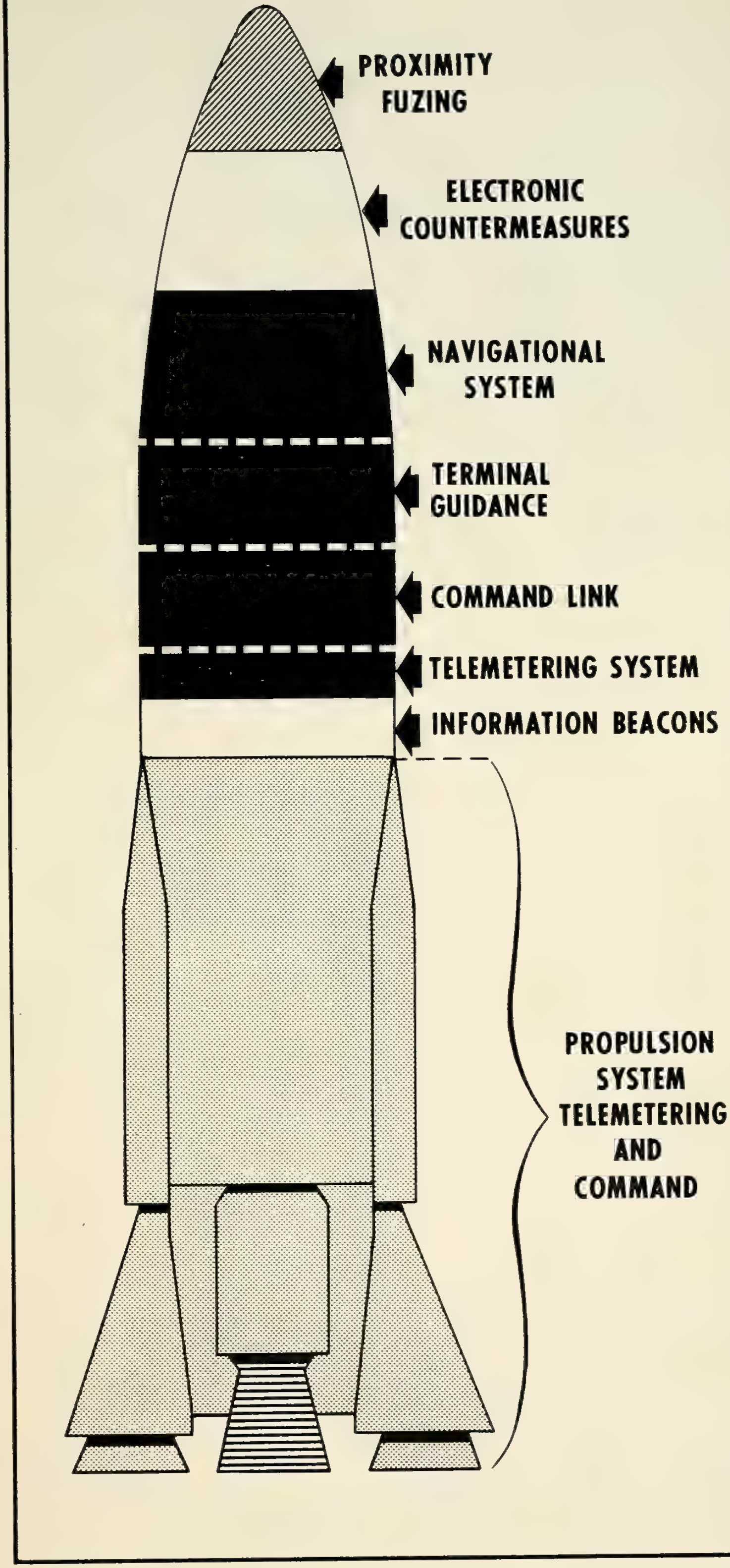
5. **Attenuation**—Standing waves, resulting from poorly matched components or devices, also result in signal attenuations. Typical improvements shown in a recent missile were VSWR reduced from 3:1 to 1.5:1, with an associated reduction in attenuation of about 20%.

6. **Cross-talk**—Interference between systems is a very serious problem and one that must be solved early in the antenna system layout. Antenna isolation, side lobes, filter characteristics, switching arrangements, are critical in this study.

7. **Weight-space**—Very often these factors force antenna system design into a certain configuration, just as will aerodynamic and structural considerations. Antennas will be made smaller than is desirable electrically, and a better matching unit will be used. Running a single cable to a single antenna will force diplexing to save weight over two cables and two antennas.

8. **Reliability-complexity** — These need to be studied critically. Since most matching and filter devices have no moving parts, complexity can often be reduced with corresponding improvements in system reliability.

9. **Cost**—It has been demonstrated quite convincingly that a system of matched components works better and costs no more than a composite system. One of the reasons that this is so is that more realistic specifications can be assigned to each component.



SOME OF the antenna requirements on a typical missile. (Right).

New Infrared Detector Uses Germanium

An infrared detector that can respond to less than one-twentieth of a billionth of a watt of radiation promises to have application in missile detection programs now underway.

The ultra-sensitive detector was developed by scientists of the Westinghouse Research Laboratories in consultation with Dr. Henry Levinstein of Syracuse University. It is a photoconductor unit, uses germanium, and operates at –320°F.

Germanium, a solid material, changes its ability to conduct electricity when radiations such as infrared or visible light strike its surface. Because of this, intensity changes in infrared radiation reaching the photoconductor are converted into changes in electrical current flow.

The germanium used in the detector is not standard, but has been made sensitive to infrared by doping it with gold. The addition of gold as an impurity has two advantages: it provides increased sensitivity and increases response to the longer infrared wavelengths.

Longer wavelengths, corresponding to lower IR temperatures, are often the ones most desirable to detect, but are often the most difficult. Very little difficulty is encountered in observing a red-hot object with a temperature of somewhere around 1,500 degrees and an IR radiation wavelength of three microns (100 millionths of an inch.)

However, when it is necessary to detect an object at body temperature (98.6°F), an entirely different situation exists. Peak infrared radiation has tripled to a wavelength of about nine microns and total energy emission has dropped to less than one-hundredth of its previous value.

The problem that faced Westinghouse was to provide a detector that responded to the long-wavelength radiations, had good sensitivity over the range of IR frequencies and reacted rapidly enough to be useful in practical situations.

According to Dr. J. W. Coltman, manager of the Westinghouse electronics and nuclear physics department, the new detector is highly sensitive up to a wavelength of 10 microns, which corresponds roughly to the peak radiation at room temperature. "At the same time," Dr. Coltman said, "it is about 10 times faster than any previously measured photoconductor detector." It is so fast in its response, he said, that special laboratory apparatus had to be developed to test its speed.

Westinghouse uses a mechanical light chopper that breaks infrared into pulses only a few billionths of a second duration. The pulses, reflected to the surface of a detector, show its time constant to be two-tenths of a millionth of a second. The detector is cooled to its operating temperature by surrounding it with liquid nitrogen.

Because of the initial success of its IR program, Westinghouse plans early production of the new detector.

International Electronics Competition Threat to U.S.

Electronic engineers attending the 30th anniversary of the Radio Fall Meeting were warned that they face serious international competition by Electronic Industries Association President David R. Hull.

He spoke at a three-day technical conference held October 27 to 29th, Rochester, N.Y. The 30th anniversary of the Radio Fall Meeting, sponsored jointly by EIA and IRE, drew more than 300 engineers.

Speaking on "Engineering Maturity," Hull told industry engineers that their high salary and living standards are at stake unless they avoid wastefulness from over-design and help overcome foreign competition by better engineering to bring about greater production.

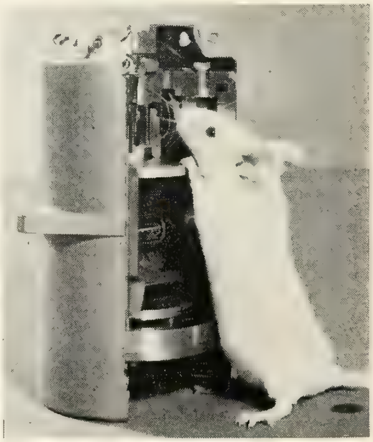
Tracing the rise in importance of electronic engineers during the past decade, Hull said that there are now 50,000 engineers and an equal number of electronic technicians.

An admission of ignorance, willingness to seek help from others and a study of earlier successes and failures in the same field were mentioned by Hull as examples of engineering maturity.

The mature engineer solves his problems by simplification and deletion, not by added complexities, he said.

Some 24 technical papers were presented during the conference.

Ready to Go



A MOUSE, whose offspring may someday be a space traveler, inspects an autopilot gyroscope manufactured by Minneapolis-Honeywell for the *Thor* and *Atlas* missiles. The two-pound unit can withstand 100-g shocks and operates from —65 to +175°F.

Missiles Figure Heavy in Electronics Applied R&D

Ninety-eight per cent of the $1.4 billion spent in 1956 for electronics applied research and development came from fifteen industrial categories. Of the fifteen categories, ten are concerned with missiles.

The figures were released by the Electronics Industries Association. The study, which resulted in this preliminary data, was performed by the National Science Foundation and the statistics were compiled by the U.S. Bureau of Labor Statistics. This is the first comprehensive survey ever made of the total electronics R&D picture.

Total R&D expenditures, both basic and applied, jumped from $3.6 billion in 1953 to $6.5 billion in 1956, an increase of 76%. Of the fifteen categories, Aircraft and Associated Parts show the largest growth, up 174% in the three-year period.

During 1956, nearly half, or $3.1 billion, of the total came from the government. The comparable figure for 1953 was about one-third, or $1.4 billion.

NSF held itself to the standard industry classifications and excluded numerous activities which would have added a considerable amount to the total. The sectors of the economy excluded were government, universities, commercial laboratories and non-profit institutions. Costs of quality control, routine product testing, market research, sales and technical services were also omitted from the study.

A final report covering more detailed aspects of 1956 industrial research is scheduled to be released by NSF in the near future and information about subsequent years will be available soon afterward.

Parts for electronic-electrical systems totalled $669.6 million in applied R&D. In the same category, machinery (including computers), was $182.1 million; telecommunications and broadcasting, $137 million; professional and scientific instruments, $64.5 million.

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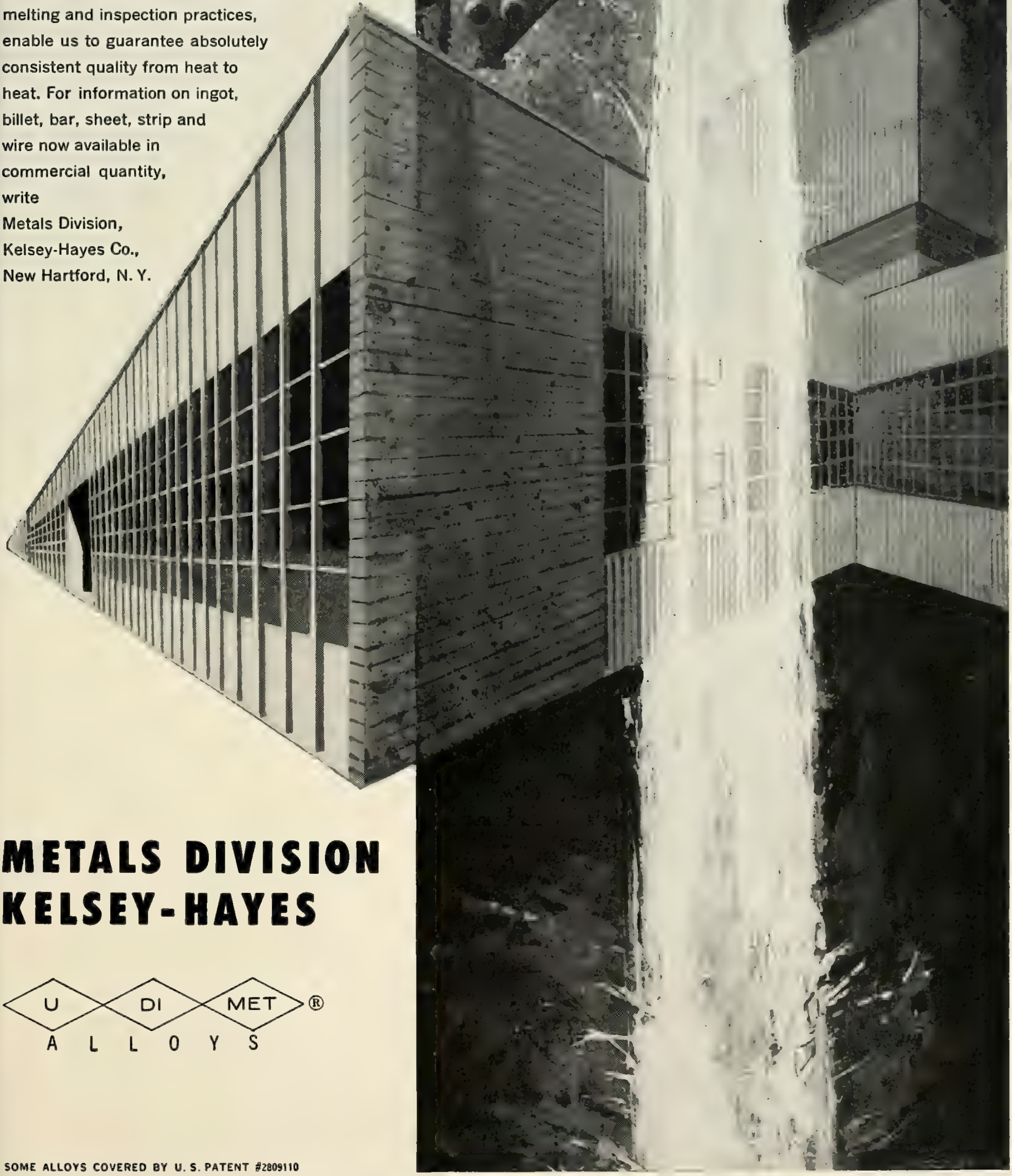

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letters

ABMA Transfer

To the Editor:

I was somewhat more than surprised to see the story on The Association of the U.S. Army Annual Meeting in your October 27th issue under the headline, "AUSA Avoids ABMA Transfer."

I quote from the first paragraph the following sentence: "There was absence of any mention of the proposed transfer of Army Ballistic Missile Agency (ABMA) to the National Aeronautics and Space Administration (NASA) and the discussed possibility that Army may be on its way to losing its coveted missile capability."

I recognize that you were working against an early deadline which made it necessary for you to work from prepared text. However, it is disturbing to have this erroneous impression carried in such a widely circulated publication as yours.

The facts are these: Our Resolution No. 1 (which asks the President to continue to maintain the present general organization of the Army Ordnance Missile Command) was unanimously passed by the Association at the meeting. A letter to the White House directed by this resolution has already been transmitted.

Both Gen. Trudeau and Gen. Medaris discussed this subject candidly and freely during the panel discussion on our Wednesday morning program.

The story as it appeared gives the definite impression that the Association studiously avoided a most important topic of our National Defense, which would in effect indicate that we are reluctant to face important Defense issues simply because they happen to be somewhat controversial.

We would very much appreciate anything that you can do to set the record straight.

Robert F. Cocklin
Director of Public Relations
Association of the U.S. Army

The article specifically said "in prepared texts, no mention was made of the proposed transfer of ABMA." The subject was brought up in a panel discussion and a press conference on the last day of the meeting, after m/r had gone to press. While the association avoided the subject during the first two days, it did, however, take action on the last day. . . . Ed.

The editors of MISSILES AND ROCKETS welcome contributions from readers in the form of letters. Letters should be addressed: "To the Editor, Missiles and Rockets, 1001 Vermont Ave., N.W., Washington 5, D.C." They should be signed and should include company or other affiliation of the writer.

Equatorial Site

To the Editor:

I am writing concerning the articles in m/r about plans to build an equatorial launching site for putting satellites into low-latitude orbits.

In the February 1955 issue of the JOURNAL of SPACE FLIGHT, publication of the Chicago Rocket Society, Lewis J. Grant, secretary, published an article entitled "Location of a Permanent Rocket Base."

In this article, Mr. Grant suggested using the extinct craters of Mt. Kilimanjaro, a volcano in Kenya, Africa, as a permanent base, not only because it is near the equator but the high altitude of the launching site would greatly increase the efficiency of the rocket motors. Atmospheric back-pressure at the 18,000-ft. altitude is only half that at sea-level (14.7 psi).

Also, since the base is only some 100 miles from the Indian Ocean, rocket stages could be dropped where they could be recovered and would not be a hazard to people living on the land beneath the rocket's flight path.

However, Mt. Kilimanjaro is at a disadvantage for a launching site due to its great distance from the continental United States, and its relative inaccessibility to land transportation.

There is, however, a possible launching site much closer to the United States; that is Mt. Popocatepetl in Mexico.

George Carruthers
Member, Chicago Rocket Society

contract awards

ARMY

By Headquarters, Redstone Arsenal, U.S. Army OMC, Redstone Arsenal, Ala.:

Norris Thermador Corp., Los Angeles, Calif., received $38,446 for fabrication of T-273 rocket motors and T-273 rocket warheads; and $33,815 for designing, developing, and fabrication of 17 rocket motor cases.

By the U.S. Army Electronic Proving Ground:

Tele-Dynamics Inc., Philadelphia, Pa., designer and producer of telemetry equipment for missiles and drone aircraft, has been awarded a $320,000 contract to design, manufacture, and install radio telemetry equipment for flight testing of surveillance drones.

By U.S. Army Engineer Dist., N.Y. Corps of Engineers:

S.T.G. Construction Co., Inc., New York, received $67,800 for Fy-59 special AAA facilities, construction of missile assembly and test bldg. and warhead facilities, Ft. Hancock, N.J.

Advertising correspondence should be addressed to Advertising Sales Manager, Missiles and Rockets, 17 East 48th Street, New York 17, N.Y.

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advertisers' index

American Beryllium Co. Agency—Gilmore-Rice Adv.	4
Arnoux Corp. Agency—Kay Christopher Adv.	2
Consolidated Electrodynamics Corp. Agency—Hixon & Jorgenson, Inc.	15
Diversey Engineering Co. Agency—Roark & Colby, Adv., Inc.	6
Dow Chemical Co., The Agency—MacManus, John & Adams, Inc.	29
English Electric Co., Ltd. Agency—Gotham-Vladimir Adv.	18
Food Machinery & Chemical Corp. Agency—The McCarty Co.	21
L. O. F. Glass Fibers Co. Agency—Wade Advertising Agency, Inc.	26
Lukens Steel Co. Agency—J.M. Mathes, Inc.	25
Narmco Resins & Coating Co. Agency—Riley-Nelson Co.	35
National Electric Products Corp. Agency—PMS Adv. Agency	8
Raytheon Mfg. Co. Agency—Donahue & Coe, Inc.	3
Shell Oil Co. Agency—J. Walter Thompson Co.	10
Solar Aircraft Co. Agency—The Phillips-Ramsey Co.	12
Sundstrand Turbo, Div.-Sundstrand Machine Tool Co. Agency—The McCarty Co.	23
Utica Drop Forge & Tool Corp., Div.-Kelsey-Hayes Co. Agency—Zimmer, Keller & Calvert, Inc.	33
Varian Associates Agency—Boland Associates	36
WaiMet Alloys Co. Agency—The Ken Fox Co.	17

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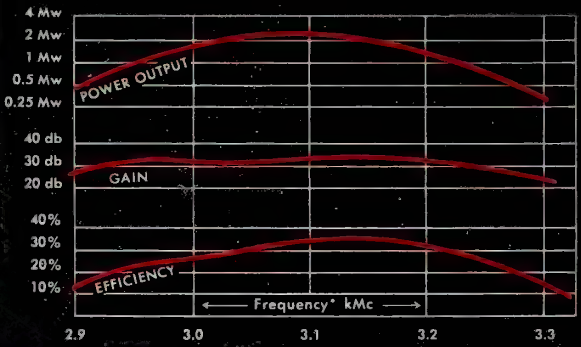

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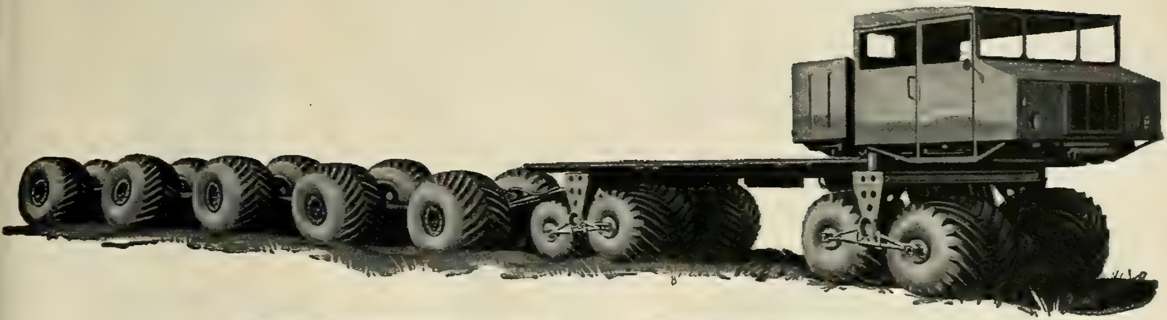

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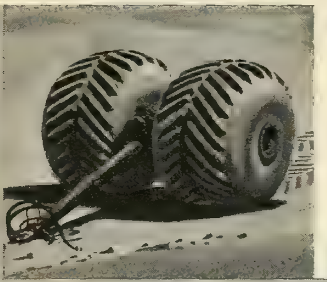

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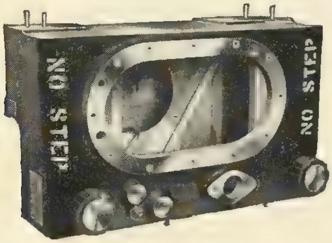

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in this issue

NOV. 17 HEADLINES

Outlines of the U.S. Missile Industry
Special m/r report gives statistical information on this major force in the nation's industrial machine 11

Field Open for Army Lunar Probes
Two separate firing dates are open in December for four-stage vehicle relying heavily on *Sergeant* clusters 14

ARS Gears for Record Attendance
Some 4,000 engineers and scientists expected for 1958 convention which will have 16 sessions, including three on space flight 16

Commander George Hoover: 'Curious' Space Man
Special m/r profile tells of his pioneering work in radically new integrated flight control system 18

New Army Missiles Revealed
Information on *Missile Able, Mauler, Rattler* and *Redeye* 46

White Lance Details
Chances are the improved *Bullpup* will have liquid engine, nuclear warhead 48

ASTRONAUTICS ENGINEERING

Highway to the Stars is More than Dream
Commander George Hoover discusses ONR's "Pathway" system 19

Air Transportable Missile Trailer Available 29

Callery Ready for Boron Production 31

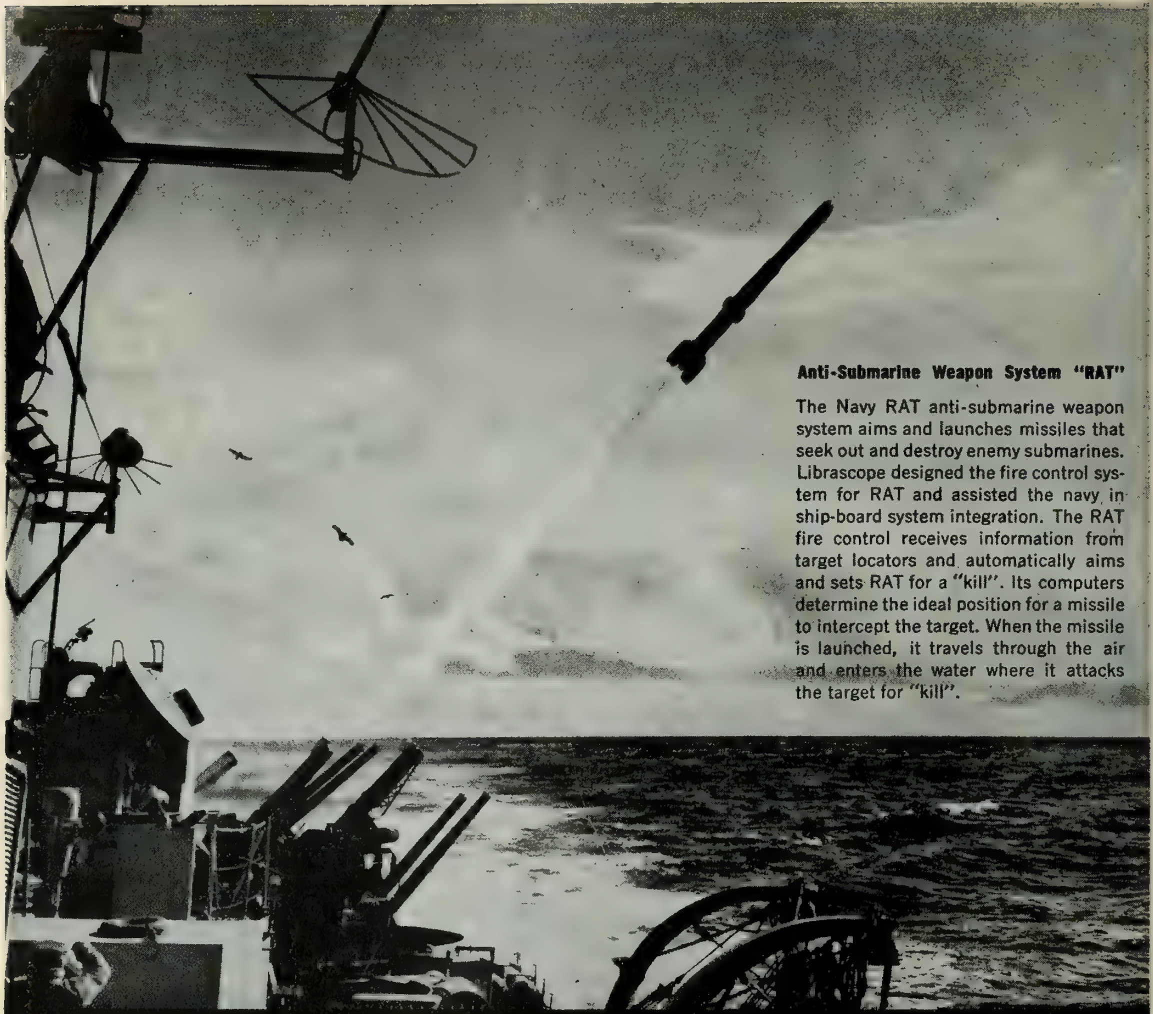
Automatic Assembly Line Testing Cuts *Falcon* Costs 34

MISSILE ELECTRONICS

Bureau of Standards: Calibration Is Its Task
Electronic calibration facilities of new Colorado facility are important to industry.

DEPARTMENTS

Washington Countdown .. 7
Industry Countdown 9
People 33
When and Where 36
Space Age 40
Keeping Track 43
New Missile Products 67
West Coast Industry 75
World Astronautics 77
Contract Awards 82
Editorial 86



Anti-Submarine Weapon System "RAT"

The Navy RAT anti-submarine weapon system aims and launches missiles that seek out and destroy enemy submarines. Librascope designed the fire control system for RAT and assisted the navy in ship-board system integration. The RAT fire control receives information from target locators and automatically aims and sets RAT for a "kill". Its computers determine the ideal position for a missile to intercept the target. When the missile is launched, it travels through the air and enters the water where it attacks the target for "kill".

RAT...a new anti-submarine weapon... the fire control was designed and developed by LIBRASCOPE

The background of more than twenty years of design, development and manufacture of computers, controls and instrumentation are inherent values in all Librascope products. This experience and versatility in electronic, magnetic, mechanical and optical design concepts make for a new kind of reliability. Whether components or complete systems, Librascope can point to notable achievements. Let Librascope *solve* your computer problem. An inquiry on your letterhead will bring further information.

Librascope's use of the LGP-30 computer simplifies complex design and production problems, and assures computer-engineered quality in meeting design and delivery schedules.

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washington countdown

ARPA is here to stay . . .

and an increased budget to about a $1 billion total will be asked for fiscal 1960. Total number of projects to be transferred to NASA is less than anticipated because of inherent military aspects which violate peace charter of the space administration. For first time, DOD is agreeing through ARPA to sponsor pure research, and is not requiring that a specific end product be identified with a weapons system.

Venus and Mars probes loom big . . .

on the Washington scene. NASA scientists said the hardware already is on the shelf which would make the probes possible. Dr. Newell Sanders, assistant director for Advanced Technology, said present vehicles with boosters are capable of supplying the 25,000 mph required for Venus and the 25,900 mph needed for Mars. The probes may follow the three AF attempts and two Army tries to the moon's vicinity.

With the election unhappily . . .

behind him, the President can turn his attention to the proposed transfer of the ABMA scientific team to NASA. Decision probably won't come until after next meeting of the Space Council, date unknown. Decision will involve ABMA and Jet Propulsion Laboratory and maybe more.

Space will take lots . . .

of space on the upcoming Congressional agenda. Number one on a list of 12 national needs, in the opinion of Senate Democratic Leader Lyndon B. Johnson, is "to breathe life into the newly created space agency and to launch a program to explore outer space." Johnson said the nation is "heading into one of the greatest expansions of its history in a century of unparalleled opportunity.

Air Force revised security . . .

restrictions covering missiles and subsystems in a recent directive. Engineering design and propulsion type information is declassified when they go into production for inventory or deployment to operational units. Details as to weight, length, performance data in general, external photos, and launch-information will be unclassified.

Electronics Warfare Simulator . . .

was unveiled at the Naval War College, Newport, R.I. The block-long, three-story high, installation will carry out realistic combat command problems on a large scale. Thirteen years in the making, NEWS simulates employment of the latest missiles, and detection gear. Pentagon budgeteers say NEWS will provide advanced training heretofore limited by high cost of actual weapons and mock fleet operations.

Marriage of missile . . .

Eagle and an aircraft is the Navy's answer to enemy forces attacking carrier task forces or amphibious landings. Vice Admiral Robert B. Pirie, Deputy Chief of Naval Operations (Air), said no new aircraft are sought for a "highly sophisticated" missile being developed for either air-to-air or air-to-ground use. Two aircraft are available—the Douglas A3D or the North American A3J. Both are capable of staying on station for four hours or more at the altitude required for such sentry duty.

Astronomical Budget is needed . . .

if NASA is to take over many of the military space projects. One reliable source estimates the Air Force alone last year spent $1 billion on space projects, in one way or another, from this budget or that.

There is no substitute for

EXPERIENCE

when it comes to producing motors for the aircraft and missile field

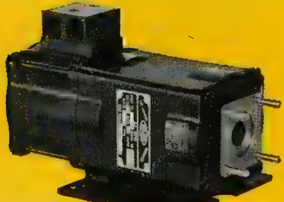
Here are eight special motors for eight different applications designed and produced by EEMCO for eight manufacturers of aircraft and missiles, and for related applications. Note the performance details for each: ratio of high output to size and weight.

EEMCO has designed and produced special motors for **thousands** of various applications in aircraft and missiles during the past 17 years. This is proof of EEMCO's unparalleled capabilities as a **specialist** in the production of high precision motors.

No matter what your problem may be in powering components for aircraft and missiles EEMCO has had experience that can help you. Your inquiry is invited.

Type D-1066

For supersonic aircraft applications. .71 HP DC motor, 7600 rpm continuous duty, 24 volt. For pump drive. Weight: 6.5 lbs. Meets MIL-SPEC M-8609.



Type D-1086

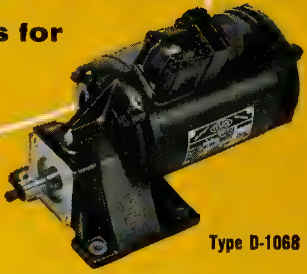
For missile applications. 9 HP DC motor, 12,000 rpm intermittent duty, 56 volt, explosion proof. Weight: 14.75 lbs. Meets MIL-SPEC M-8609.

Type D-978

For missile applications. Tested successfully at over 200,000 ft. altitude, this ⅓ HP, 27 volt DC motor (ranges 24 to 32 volts) delivers 12,000 rpm, weighs 2.75 lbs, has radio noise filter, is explosion proof. Built for high shock and vibration loading. Meets MIL-SPEC M-8609.

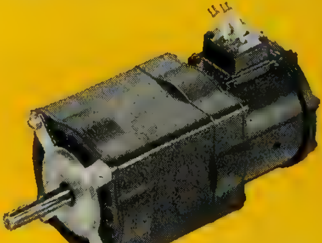
Type D-632

For fan, blower, pump applications. Only 6½" x 2¼", weight 23½ ounces, delivers 50 watts continuous duty at 7500 rpm. Long life. Small motor wound for 28 volt DC, or 110 volt AC or DC. Meets MIL-SPEC M-8609.



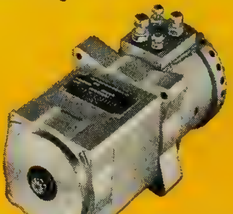
Type D-1068

For missile applications. 2.75 HP AC motor, 3140 rpm at gear box, continuous duty, 200 volt, 400 cycle, 3 phase. Power factor: 83%. Overall efficiency: 76%. Weight: 11.25 lbs. Meets MIL-SPEC M-7969A (ASG).



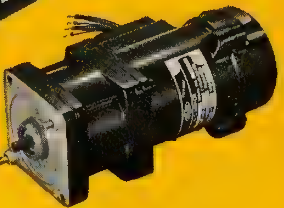
Type C-1791

For ultracentrifuge application. 1½ HP AC motor, 12,000 rpm continuous duty, 115 volt, 60 cycle, single phase, fan cooled. Weight: 12 lbs.



Type D-1025

For motor truck turbine engine applications. Starter-generator, weight 14.5 lbs. As starter: breakaway torque 220 in-lbs, terminal voltage of 20 volts. As generator: 40 amps continuously with intermittent peaks up to 80 amps at 28 volts.



Type C-1874

For actuator applications. 400 cycle, 3 phase AC motor and clutch. Intermittent duty, 12,000 rpm on 200 volts, 650 watts output. Weight: 4.5 lbs. Meets MIL-SPEC M-7969A (ASG).

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industry countdown

Full scale fluorine production . . . at Metropolis, Ill., has been started by Allied Chemical's General Chemical Division. Liquid fluorine, the key to high energy chemical propellants will also play a major role in the new multi-million dollar uranium hexafluoride plant just opened at Metropolis for the production of UF6 for the Atomic Energy program in 1959. Besides the use of fluorine for captive consumption in UF6 production, there is sufficient capacity to also supply tonnage quantities for the country's rocket and missile program.

Biggest merger story . . . lately is Sylvania Electric Products into General Telephone Corp. Details of the proposed merger are being worked out now and will be submitted to stockholders of both companies soon. The plan will swing around a one-for-one stock exchange. D. C. Power, president of General Telephone will become chairman of the board, and D. G. Mitchell of Sylvania is slated to become president.

Flight test simulators . . . for investigating flight characteristics of unflown missiles have been sold to the Army Ordnance Missile Command and Convair-Fort Worth by Bendix Aviation Corp's Computer Division. Unit price—$500,000.

Low cost research for NASA . . . in a major problem area will be conducted by the Ohio State University Rocket Research Lab. A one year research contract for $28,889 calls for investigations into factors affecting the formation of detonation waves in rocket engines in an effort to determine why the engines destroy themselves. The Ohio State engineers hope to find ways of preventing detonations by learning how it is influenced by initial gas pressure and temperature, the type of gas mixture, fuel concentration and the diameter of the detonation chamber. About $7,000 of the contract will be spent on a 12-foot stainless steel tube for carrying out the experiments.

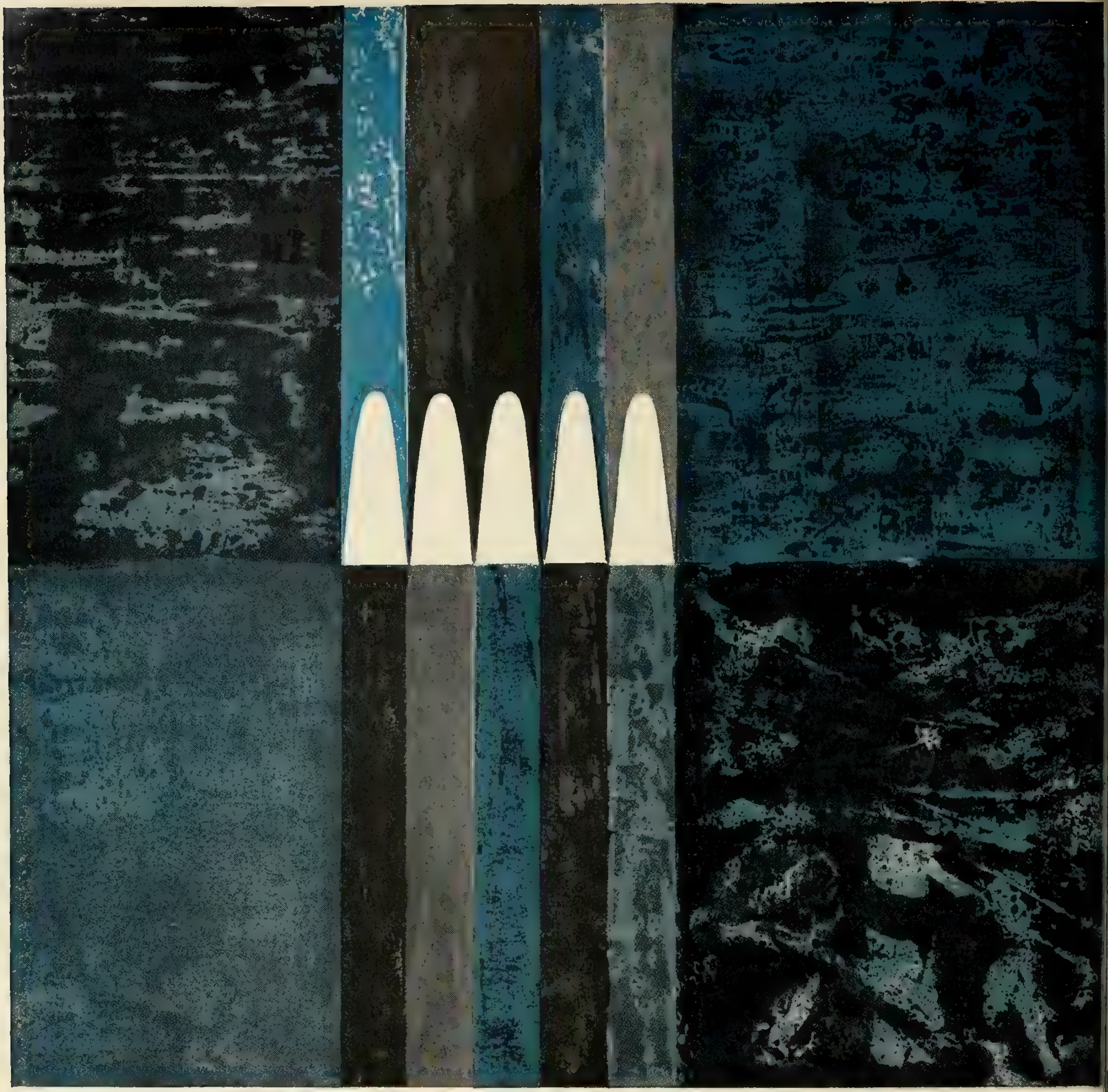
Mellon Institute . . . in Pittsburgh has reportedly formulated several new alloys that show great promise for solid fuel rocket motor casings. Several units fabricated to date when placed under test have shown reliable yield strengths over 225,000 psi. Mellon's R&D program is being backed by service funds.

Openings for technical personnel . . . may double in the next 10 years, according to a recent survey by the Scientific Apparatus Makers Association. Twenty-seven percent of 500 large firms polled replied that the demand for scientists, engineers and technicians in their organizations would be double by 1968. The rapidly expanding field of data computing and other electronic equipment is making a major demand for formally trained technical personnel.

Navy problems . . . for missile systems have really forced the issue of making missiles come of age. Contractors are now asked to provide repeated reliability for air-to-air and air-to-surface missiles under the same field conditions as artillery shells. This means two years storage in the open and six-foot drop tests as prerequisites for stock-pile weapon systems readiness. This will, without question, force stiff design requirements on the liquid storable systems planned for the *Bullpup* and *Corvus* air-to-surface missile systems. The liquid package people firmly state that this problem is within reason.

Designers of Navy . . . underwater missiles have still another problem. The velocity of the submarine and even surface-to-underwater missile structures must be able to withstand increasing dynamic pressures as a result of buildup in velocities. Specifications now call for resistances to ram water pressures of 10,000 psi.

Heavy forging presses . . . for missile builders received attention at a conference held at the Wyman-Gordon plant at North Grafton, Mass. last week. Objective was to determine the potentials of 35,000 to 50,000 ton presses required for nose cone ablation materials.



BRUNSWICK TURNS OUT SHAPES WITH FANTASTIC FIDELITY

Brunswick has revolutionized the technology of fiberglas laminates with its exclusive new Strickland B Process (SBP). This unique method not only creates components with extremely high strength-to-weight ratios and heat resistance (up to 600°F.), but it also opens up a mass production system that meets fantastic new standards for precision.

SBP filament-wound laminates can be mass produced by fully automated machines. Whether one or one thousand . . . simple or compound configurations, including monocoque structures, SBP laminates meet the most rigorous space age specifications for precision and uniformity in skin thickness, size, dielectric constant and contours.

Brunswick research and development groups continually work t extend upper temperature limit and other unique features of SBP laminates. They also offer you skillful help solving problems in design development and fabrication. Writ The Brunswick-Balke-Collender Co. Defense Products Division, 170 Messler St., Muskegon, Michigan

BRUNSWICK

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NOVEMBER 17, 1958
VOL. 4, NO. 20

missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

Here's the U.S. Missile Industry

Special m/r Report Gives Statistical Information on this Major Force in Nation's Industrial Machine

by E. E. Halmos, Jr.

The outlines of the industry that has grown up to support the U.S. missile effort are beginning to come into focus. And they show the emergence of a major force in the nation's industrial machine.

The vital statistics come out this way:

- There are 75 major prime contractors now at work.
- There are between 4,000 and 5,000 subcontractors with enough of their business volume in missile work to be identified clearly as part of the field.
- Together, these organizations are now doing an annual cash business—cash paid out for actual procurement items—of about $3 billion. And they have a backlog of about $3.5 billion of orders to work against.
- More than $2 billion is being spent—in addition to that for procurable items—for research and development.
- In addition to the business done by organizations whose work can be directly connected to missiles, there are several thousand other business groups involved—and their share may aggregate $1 billion or more. These include suppliers of raw materials, and services such as construction work.
- More than 400,000 people are now directly employed (exclusive of the military) in missile work.
- Nearly every facet of U.S. industry; probably every major university, and a very great number of individuals representing every recognized profession including the law and medicine, is taking part.

These are the key conclusions of a survey of the spectacular growth of the field they serve by the editors of MISSILES AND ROCKETS.

- **Tough to check**—It is not surprising that no conclusive yardsticks have been developed to date. Probably no industrial field has grown up so quickly—even under the spur of wartime demand—as that of missiles.

And—like its end product—the industry has grown at a fantastic speed, and in fantastic directions. It has drawn on technologies that have existed almost since men began to use machines. But it has also created technologies for which there has never previously been any need.

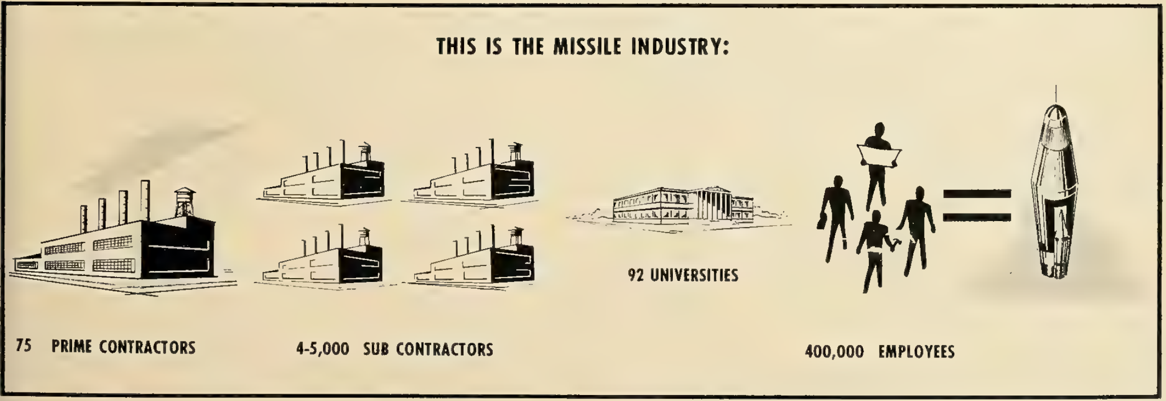
In doing so, it has drawn into its orbit every kind of manufacturer from aircraft to razor blades, sewing machines and flour millers; every kind of technician from machinist to chemist; every kind of engineer from civil to electronic; physicists, physicians, psychologists, mathematicians, and many others.

Importantly, at first, very few of these men and organizations considered themselves to be in the missile business. Most of them considered that they were still watchmakers, or machine foundries, or chemical companies—supplying know-how or manufactured items to a new customer.

Among other things, missiles have also called forth a whole new aspect of doing business, where businessmen have been asked to bid on manufacturing a product that no one ever produced before, and for which plans exist only in the vaguest form—or not at all.

For these reasons, even the U.S. Census Bureau has been at a loss as to how to check facts. When the last business census was taken four years ago, missiles didn't count at all. But in the next census—to cover the year 1958 (but with questionnaires to be mailed out in 1959, and results to be available in 1960)—the bureau is still debating what questions should be asked,

(Continued on page 14)



Missile Prime Contractors

Listed here, together with the missiles for which they have primary responsibility are the United States' major prime contractors. Omitted from the listings are U.S. government agencies.

Corporal—Firestone Tire and Rubber Co. (missile and ground handling equipment); Gilfillan Brothers, Inc., Los Angeles (ground guidance equipment).

Dart—Curtiss-Wright Corp., Utica, Mich. (missile system) and Aerophysics Development Corp., Santa Barbara.

Hawk—Raytheon Manufacturing Co., Waltham, Mass. (system).

Honest John—Emerson Electric Mfg. Co., St. Louis (fins and warhead compartments); Douglas Aircraft Co., Santa Monica (fins and warhead); Hercules Powder Co., Radford, Va. (rocket motor M3); Thiokol Chemical Corp., Marshall, Texas (spin rocket motor M7).

Jupiter—Chrysler Corp., Detroit (missile fuselage and assembly, and ground equipment).

Lacrosse—Cornell Aeronautical Laboratories, Buffalo; and the Martin Co., Orlando, Fla. (missile system).

Nike—Western Electric Co., New York (missile system).

Pershing—The Martin Co., Orlando (missile system).

Plato—Sylvania Electric Products, Inc., New York (missile system).

Redstone—Chrysler Corp., Detroit (missile system).

Sergeant—Jet Propulsion Laboratory, Pasadena (system); Sperry—Utah Engineering Lab., Salt Lake City (all critical R&D components), Thiokol (propulsion).

Corvus—Temco Aircraft Corp., Dallas Reaction-Thiokol (propulsion).

Polaris—Lockheed Missile Systems Division, Sunnyvale (system).
Components:
Aerojet General Corp., Sacramento (propulsion); Massachusetts Institute of Technology (guidance development); General Electric Co., Pittsfield, Mass. (guidance production and fire control); Interstate Electronics Corp., Anaheim, Calif. (instrumentation); Westinghouse Corp., Sunnyvale (launcher design).

Rat—Librascope Inc., Glendale, Calif. (fire control system); Clevite Ordnance Inc., Cleveland (torpedo); Allegany Ballistics Laboratory, Cumberland, Md. (design of rocket).

Regulus I and II —Chance-Vought Aircraft, Inc., Dallas (system).

Sidewinder—Philco Corp., Philadelphia; General Electric Co., Utica, N.Y., (system).
Components:
Norris-Thermador, Los Angeles (propulsion, metal parts); Bridgeport Brass Co., Riverside, Calif. (propulsion metal parts); Eastman Kodak Co., Rochester, N.Y. (fuze); Minneapolis-Honeywell, Minneapolis (fuze); Elgin Watch Co., Elgin, Ill. (fuze); Baldwin Piano Co., Cincinnati, (fuze); Hubeny Bros., Roselle, N.J. (warhead, metal parts); General Time Corp., LaSalle, Ill. (safety and arming devices); Hamilton Watch Co. Lancaster, Pa. (safety and Arming devices); Lasko Metal Products, West Chester, Pa. (shipping containers).

Sparrow III—Raytheon Mfg. Co., Bedford, Mass. (system).

Subroc—Goodyear Aircraft Corp., Akron (system).

Talos—Bendix Aviation Corp., Mishawaka, Ind. (system).
Components:
Allegany Ballistics Laboratory (propulsion design development and pilot production); Sandia Corp., Albuquerque, N.M. (warhead); New Mexico State College, Socorro (warhead development); The Hicks Corp., Hyde Park, Mass. (booster metal parts); M. W. Kellogg Co., Jersey City, N.J. (booster metal parts); Sperry Gyroscope Division, Great Neck, N.Y. (radar set and computer); General Electric Co., Pittsfield, Mass. (launching systems); Bulova Research Lab., New York (safety and arming device); Melpar, Inc., Washington, D.C. (fuze); Northern Ordnance Inc., Minneapolis (power drives for launching system); Erco, division of ACF, Riverdale, Md. (warhead).

Tartar —General Dynamics Corp., Pomona, and Applied Physics Laboratory, Silver Springs, Md. (design and development).
Components:
New Mexico Institute of Mines & Technology, Socorro (warhead development); Bendix Aviation Corp., North Hollywood (fuze research and development); Philco Corp. (fuze); Aerojet General Corp. (systems engineering); Vitro Laboratory, Silver Spring (systems engineering); Raytheon Mfg. Corp. Wayland, Mass. (guidance system); Sperry-Rand Corp., New York (computer); General Electric Co. (gun and missile director); Elgin National Watch Co., Burbank, Calif. (safety and arming devices); Northern Ordnance Inc. (power drives for launching system); Western Electric Co., Winston-Salem, N.C., (weapon direction).

Terrier—General Dynamics Corp., Pomona (system).
Components:
M. W. Kellogg Co. (booster & sustainers); Cameron Iron Works, Houston (booster and sustainer); The Hicks Co. (booster and sustainer); Northern Ordnance Inc. (booster and sustainer); Philco Corp. (launcher) Elgin Natl. Watch Co., Burbank (Safety and arming devices); Thompson Products, Cleveland (power drives); Vitro Laboratories (systems engineering); Sperry-Rand Corp., New York (computer); Midway Co., Lodi, N.J. (warhead metal parts); Firestone Tire & Rubber Co., Los Angeles (back fitting for launchers); Pacific Car & Foundry, Renon, Wash., (missile carriers); Universal Match Corp., Ferguson, Mo. (launcher); Sperry-Rand Corp., Sperry Gyroscope Div., Great Neck, N.Y. (radar set); Western Electric Co. (direction equipment).

Atlas—Ramo-Wooldridge Corp., Los Angeles (technical assistance); Convair, Los Angeles (frame); General Electric Co. (nose cone); North American Aviation, Los Angeles, (propulsion); General Electric Co. Burroughs Inc., Paoli, Pa. and Arma (guidance); American Machine & Foundry Co., Pacoima, Calif. (auxiliary power units).

Bomarc—Boeing Airplane Co., Seattle.

Goose—Fairchild Engine & Airplane Co., Hagerstown, Md., and Ramo-Wooldridge Corp.

Falcon—Hughes Aircraft Co., Culver City, Calif.

Genie—Douglas Aircraft Co., Santa Monica, Calif.

Green Quail—McDonnell Aircraft Corp., St. Louis and Boeing Airplane Co.

Hound Dog—North American Aviation, Inc., Downey, Calif.

Mace—The Martin Co., Baltimore and Goodyear Aircraft Co., Akron.

Matador—The Martin Co.

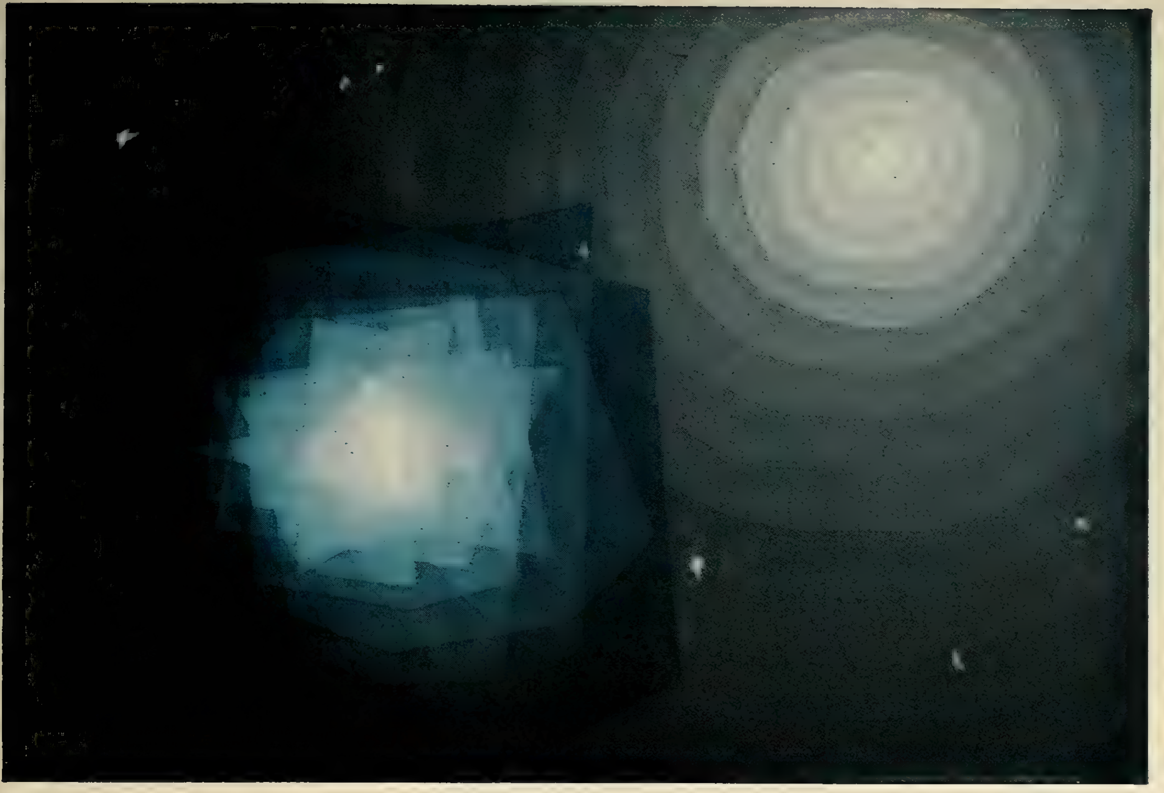
Minuteman—Boeing Airplane Co., Seattle, AVCO Mfg. Co., Stratford, Conn.; North American Aviation, Inc.; Thickol Chemical Corp., Ogden, Utah; Aerojet General Corp.

Rascal—Bell Aircraft Corp., Buffalo, N.Y.

Snark—Northrop Aircraft Inc., Hawthorne, Calif.

Thor—(Associate contractors) Thompson-Ramo-Wooldridge; Douglas Aircraft; General Electric; North American Aviation; A. C. Spark Plug Co., Milwaukee; Sandia Corp.

Titan —(Associate contractors) Thompson-Ramo-Wooldridge; the Martin Co.; AVCO; Bell Telephone Laboratories; Whippany, N.J.; American Bosch Arma, Garden City, N.Y.; Sperry Rand, St. Paul, Minn.; Aerojet-General; Sandia Corp.



"EARTH IN SPACE," one of a series of paintings of the planets by Simpson-Middleman, painters who have been finding their subject matter in science. To quote them: "Earth is distinguished among the planets by its oceans of water and its single moon. From these as a starting point, earth in this painting has been imagined as a configuration of intersecting planes—layer on layer of blue—until it becomes a transparent crystal, glowing in space." Painting courtesy John Heller Gallery, Inc.

Space power

The newest, most advanced Air Force missile project is Minuteman—a weapon system built around solid-propellant intercontinental ballistic missiles. Minuteman is under accelerated development for use by the Strategic Air Command, with the Air Force's Ballistic Missile Division managing the program.

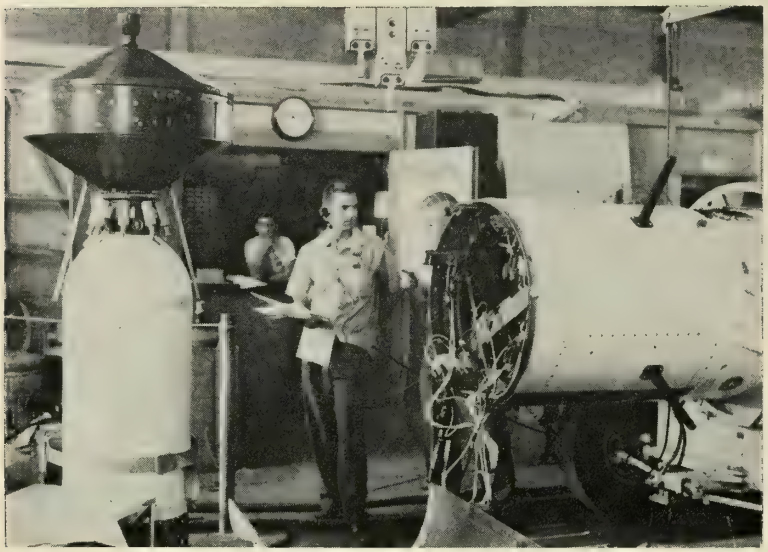
Boeing is associate prime contractor for Minuteman assembly and test—an assignment that came to the company in recognition of its missile and system integration experience, its outstanding facilities and research capabilities. Boeing's organization, research and manpower resources have been geared to meet the complex technological needs of the space age.

Engineers and scientists at Boeing are at work on other advanced research and development projects, including Dyna-Soar, a manned space vehicle that will orbit the earth at speeds approaching 18,000 miles an hour, and be capable of re-entering the atmosphere and making a normal landing.

Minuteman, Dyna-Soar and other advanced projects at Boeing offer exceptional space-age opportunities to engineers and scientists of all categories. Drop a note to Mr. Stanley M. Little, Department **R-82** Boeing Airplane Company, Seattle 24, Washington.

BOEING

Three Down, Two Probes to Go



AIR FORCE moon probes had rigid checkout, but failed.

WASHINGTON—With three somewhat less than successful Air Force attempts to place a satellite in orbit around the moon to profit by, the Army is moving cautiously toward its own two scheduled lunar probes.

The first opportunity for the launching from Cape Canaveral will come early in December. Due to peculiarities in the moon's orbit, the possible dates are December 4, 5, 6 or 7 and then December 10, 11 or 12. The Army's probe, carried out under the direction of NASA, will not attempt to place a payload in a lunar orbit, Army officials said. Army will simply try to shoot the fourth stage past the moon, coming as close as possible.

Under the original schedule the Air Force was given three attempts, the last in November, while the Army was given two tries, one in December and one in January. Presumably these might be delayed. As m/r went to press, Maj. Gen. John B. Medaris, chief of the Army's Ballistic Missile Command was moving slowly.

The first stage of the Army's vehicle is to be an IRBM *Jupiter*. The last *Jupiter* firing from Canaveral was not successful.

There are one and perhaps two *Jupiters* scheduled for test firing from the Cape during November. If these should prove unsuccessful it is quite likely the space shot may be postponed. The Army does not want to waste its advanced stages on a faulty booster and, equally important, the Army does not want to fail.

• *Sergeant* **clusters**—According to the best information available, the Army vehicle will consist of the *Jupiter* booster, modified and elongated to provide more fuel, thus more thrust, a second stage of 11 clustered *Sergeant* rockets, a third stage of three *Sergeants* and a fourth stage of one *Sergeant*. The *Sergeant* is a highly-reliable, solid rocket. Since the Army is not trying for orbit, there will be no verniers and no retro-rocket.

The third Air Force try at 0230 hours on November 8, failed after a fine start. The *Thor* booster performed perfectly. The second stage (*Vanguard*) engaged and fired.

The third stage disengaged from the second and this fact, reported by the telemetry system, caused a premature report that the third stage had fired and all was well. It was not until 12 minutes later that doppler reports disclosing that the vehicle was losing velocity made it apparent that the third stage had not fired.

The probe reached a velocity of 16,000 miles an hour (24,000 plus is needed to reach the moon's area), and an altitude of only 1,000 miles.

... *the missile industry*

(Continued from page 11)

and who should be asked, to show up the impact of missiles.

Numerous trade and professional groups—most notably the Aircraft Industries Association—have also attempted to take some measure of the field. Included in this list are such groups as the Electronics Industries Association, the U.S. Chamber of Commerce, a number of technical societies. Other government agencies, like the Small Business Administration, the Department of Defense and its branches, have also attempted to establish some boundaries.

• **How to do it**—Most of these attempts have been made from some special viewpoint, or for some special purpose. The overall picture, keyed in the opening paragraphs of this article, was developed after an intensive survey of available sources of information, comparison, and the addition of special knowledge developed by the m/r staff itself.

For example, m/r's special market guide issue (April, 1958) listed 3,200 manufacturers involved in the missile field. The association of Missile and Rockets Industries has card indexes now listing more than 4,000 such firms. AIA has additional information, developed from inquiries to its own members, many of whom are prime contractors. (One missile alone—the Atlas—involved a prime contractor and six associates and no less than 1,209 subcontractors and suppliers). DOD, SBA and others have other lists.

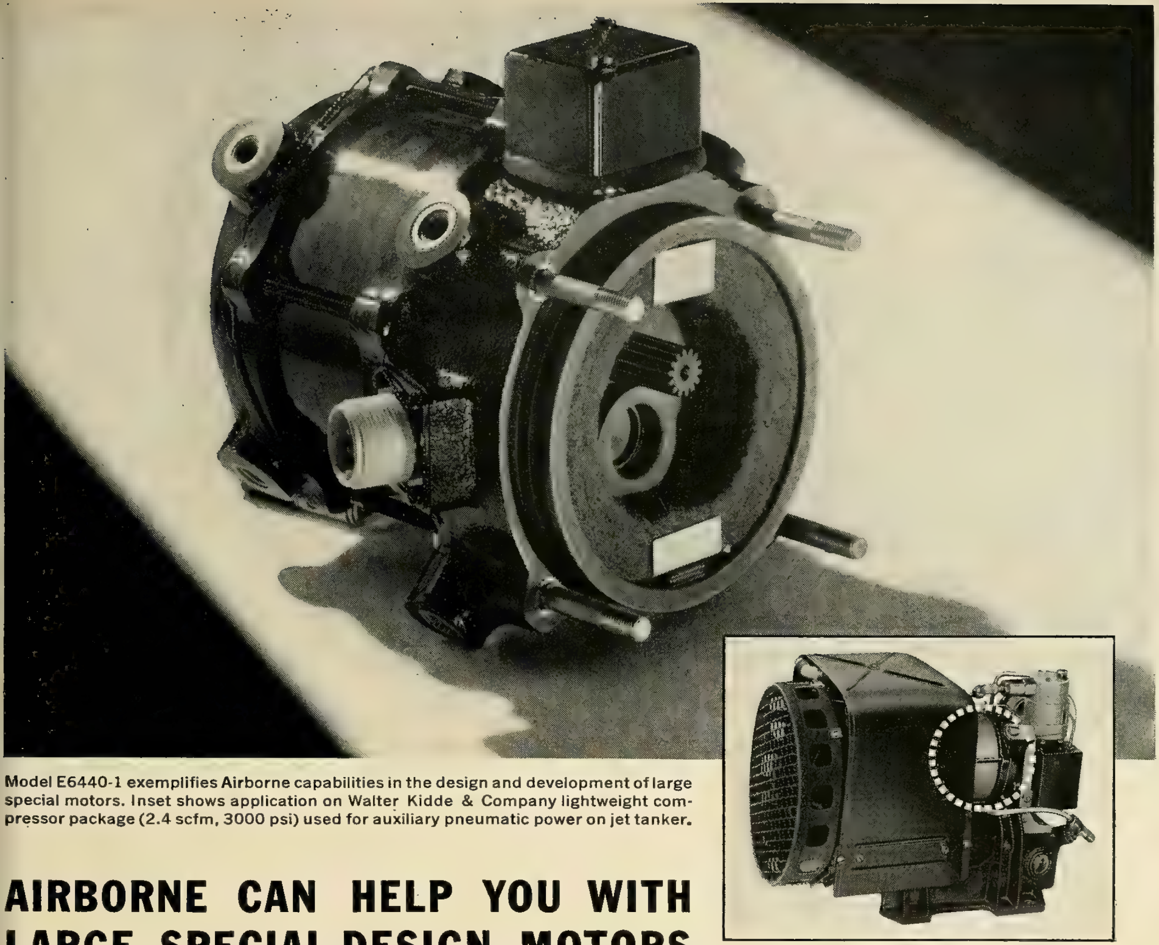
A comparison of these statistics revealed some duplication, and some listing of firms that could not be definitely tied to the missile business—companies, for instance, producing a standard material which is used in missiles, but which also may be used in many other products.

Elimination of these factors produced the figure of between 4,000 and 5,000 subcontractors, who could definitely be tied into missiles.

As to employment totals (the 400,000 figure), all concerned agreed that a probably conservative estimate of employees of any subcontractor would be 50 persons—to account for very small operations, but allow for much larger ones (one California subcontractor, for instance, has more than 9,000 employees), and to allow a further factor for company employees who might not be chargeable to missile work alone.

Money figures are more easily obtainable. According to the Department of Defense, a total of $2.7 billion was spent for "procurable missile items" during fiscal year 1958. As of August, 1958, $442 million more was spent for such items. And as of the same date,

(Continued on page 53)



Model E6440-1 exemplifies Airborne capabilities in the design and development of large special motors. Inset shows application on Walter Kidde & Company lightweight compressor package (2.4 scfm, 3000 psi) used for auxiliary pneumatic power on jet tanker.

Photo courtesy Walter Kidde & Company, Inc.

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GENERAL ENGINEERING DATA

Airborne Special Design
Motor E6440-1

1. 115/200 v a-c, 400 cycle, 3 phase (conforming to MIL-M-7969A)
2. Rated 1.7 hp at 10,900 rpm—10 in-lb full load torque; 25 in-lb starting torque
3. Duty cycle: 30 min. on at full load/30 min. off
4. Ambient temperature: −65 to +165°F
5. Altitude: to 50,000 ft
6. Weight: 8.8 lb

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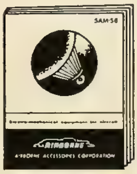

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ARS Gears for Record Attendance

Some 4,000 engineers and scientists expected for this year's broadened program of 16 sessions of which three will deal with space flight subjects

by Norman L. Baker

NEW YORK—The growth of the American Rocket Society at the end of the first year of the Space Age is dramatically represented by the size and scope and advanced attendance reservations for its annual meeting being held this week at the Hotel Statler.

For the first time in 12 years the ARS will hold its always eventful year-end meeting without the co-assistance and association of the American Society of Mechanical Engineers. The past relationship with the ASME had to be discontinued because of increased attendance resulting in a lack of hotel space.

For the ARS's first "go it alone" a record 4,000 engineers and scientists are expected to converge during the five days of this 13th annual meeting and astronautical exposition. Most of the 16 sessions on the agenda relate in some way to space flight. The broadening scope of the ARS program committee is illustrated by such session headings as "Sealed Cabins," "Psychophysiology," "Magnetohydrodynamics," and "Nuclear Propulsion." These three sessions, devoted entirely to space flight, is in contrast with the single Space Flight Symposium held at past annual meetings.

• **Many classified sessions**—The meeting is loaded with classified sessions—five in all, ranging from confidential to secret in nature. Although the ARS has held many classified sessions in the past, many of the members feel that such sessions are too restrictive to the general membership. This prevents many members from fully participating in the major function of the ARS—the dissemination of data and information vital to continued progress in the astronautics field. All of the classified sessions are being sponsored by the Army Ballistic Missile Agency.

AF Col. John P. Stapp, famed for his rocket sled experiments and this year's national vice-president, is expected to take over the fast growing society for 1959. The vice-presidency for the coming year is expected to go to H. S. Seifert, program chairman.

Hugh L. Dryden, deputy administrator for NASA, Roy W. Johnson, director of ARPA, and Simon Ramo, president of Space Technology Labs will be the guest speakers for Tuesday, Wednesday and Thursday, respectively.

COL. JOHN P. STAPP expected to be 1959 ARS president.

The main event of the meeting, the Honors Night Dinner, has been moved from the final event of past meetings to a center position on Wednesday. In addition to the guest speaker (who has not been announced), other attractions will be presentation of awards to outstanding men in the field of missiles and astronautics. Most of the awards will go to men who have contributed to the advancement of space travel during the past year.

Richard Canright, ARPA, will receive the Robert H. Goddard Memorial Award; the James H. Wyld Award will go to Army Brig. Gen. Holger N. Toftoy; the G. Edward Pendray Award to Homer E. Newell of the Naval Research Lab.; the ARS Astronautics Award will go posthumously to the late AF Capt. Iven C. Kincheloe Jr., and the Hickman Award to Barnet Adelman of Ramo-Wooldridge.

• **Honorary memberships**—Fellow membership awards have been increased to twelve. Recipients of the honorary memberships will be Brig. Gen. Homer Boushey, USAF Director of Advanced Technology; C. T. Draper, MIT; Robert Gross, Fairchild Engine Division; Dan Kimball, Aerojet-General; Rear Admiral W. F. Raborn, Navy Bureau of Ordnance; Herbert Friedman, NRL; R. D. Gompertz, General Electric; Antoni K. Oppenheim, University of Calif.; Dr. Ernst Stuhlinger, ABMA; Abe Silverstein, NASA; James W. Wheeler, Sperry Gyroscope; and Louis Ridenour, Lockheed Missile Systems Division.

The Section Delegates Conference will be repeated for the second year due to the tremendous response at last years conference. The conference affords ARS sections the opportunity to discuss administrative, financial, and policy problems encountered during the past year. Before the delegates conference was initiated the only time all the sections were represented at one meeting was at the section luncheons. The lack of time at these affairs prevented any actual "meeting of the minds." The Eastern Regional Student Conference, back for a repeat performance, has received an encouraging response with six papers to be presented. Both conferences will probably be listed hereafter as permanent affairs.

• **Many exhibitors**—Most of the major missile manufacturers will be exhibitors at the Second Annual ARS Astronautical Exposition. Representing the technical progress of astronautics, models of space ships, missiles, hardware components and equipment will occupy some 16,000 square feet in the Terrace Ballroom and the Penntop.

The past year has been the most prosperous of the American Rocket Society's history. Membership has jumped from more than 7,000 to approximately 12,000. Corporate memberships moved from 95 to 150, indicative of the increased industrial participation in the space age. Sections have increased from 34 to 41 and student chapters from 8 to 15. Total income for the ARS rose from $453,000 to $650,000.

• **Meeting program**—Partial listing of sessions follows:

Monday, Nov. 17
    Propellants
    Psychophysiology
    Combustion
    Nuclear Propulsion
Tuesday, Nov. 18
    Sealed Cabins
    Magnetohydrodynamics
    Thor-Able
Wednesday, Nov. 19
    Research Rocket Vehicles
    U.S. Space Capability
Thursday, Nov. 20
    Large Liquid Rockets
    Large Solid Rockets
Friday, Nov. 21
    Student Conference

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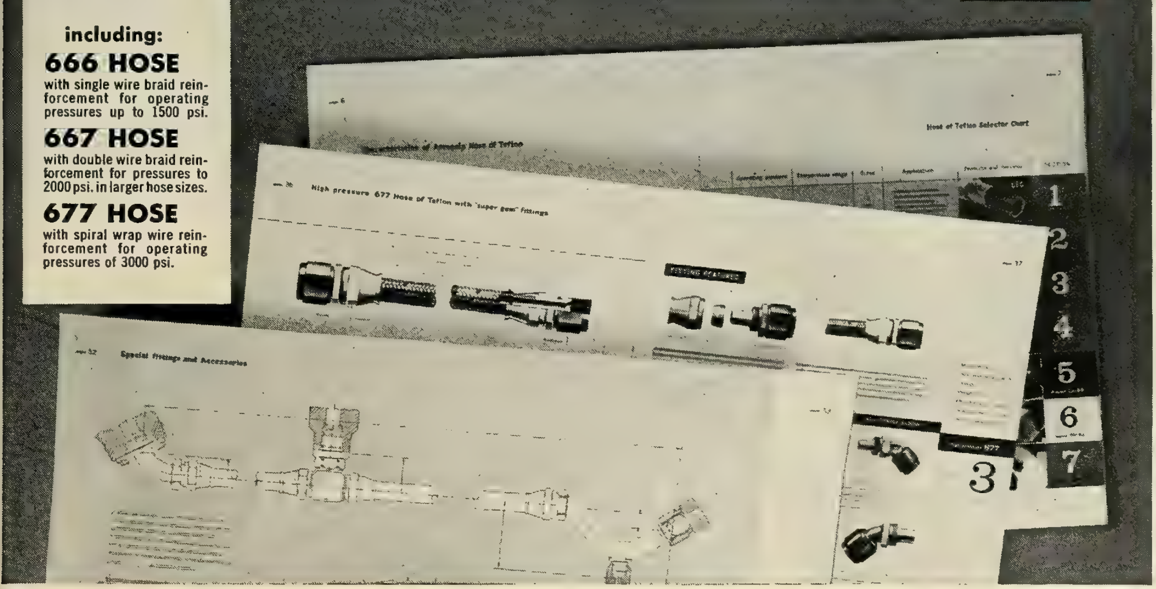

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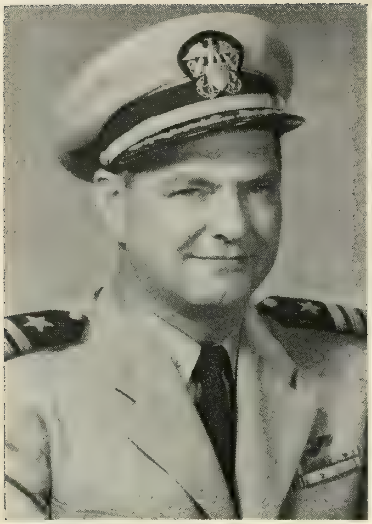


m/r personal profile

Commander George Hoover: The 'Curious' Space Man

His Work in Space Flight Resulted in Radically New Integrated Control System

by Erica Cromley

One day in 1940 a young Naval flight instructor was testing a student in the flight simulator at Pearl Harbor Naval Air Station. As he watched him struggle over the trainer's dials, the instructor suddenly realized something was radically wrong with the method.

"Here's this man," the instructor mused, "knocking himself out trying to figure out where he is from the dials, while I know exactly where he is by watching this 'crab' move along a map."

It occurred to him that they were working things in reverse; that the man in the cockpit should have the instructor's aids.

It was then that George W. Hoover, age 25, started thinking seriously about a problem that was to occupy him for many years and which was to result in the radical new concept of the Integrated Control System, described in this issue.

Although Hoover later played a leading role in this country's early space efforts, he couldn't know then that his ideas would one day show promise of reducing the complexities of space flight to little more than driving an automobile.

• **A campaign begins**—Hoover knew that if he was going to sell his ideas and have the chance to develop them, Hawaii was not the place for an active campaign. He recalls:

"I discussed at some length with Admiral Ballinger, who was at that time in charge of the Pacific Fleet, some of the ideas I had about automatic navigation and new ways of displaying it. It was through a letter he wrote, plus the need for someone with instrument background, that I was brought back to the States.

"I was ordered to Special Devices, BuAer, where they gave me the job of head of the Flight Section which was attempting to build trainers for teaching instrument flying.

Hoover's group made studies on cockpit simplification, but in 1945 he realized that a complete overhaul of instrumentation called for much more knowledge than was then available. They hired a human factors engineer —Cliff Seitz—to find out how a man thinks and operates. Psychologists were hired and asked: "If you could do anything you wanted, disregarding the problem of building the equipment, what would the ideal cockpit look like?"

12 Firms Involved in 'Pathway' System

Principal contractors in ONR's Integrated Control System are: Douglas Aircraft—coordinator of the fixed-wing program; Bell Helicopter—coordinator of the rotary wing program; Litton Industries—integrated control computer development; Kaiser Aircraft & Electronics—development of the thin TV windshield tube; Varo Manufacturing—micro-circuitry; Servomechanisms—basic materials research, sensor development; Minneapolis-Honeywell—free gyro for use as sensor; Bendix—high definition radar.

The four firms which made the original human engineering studies were General Electric, Dunlop and Associates, Deflores Engineering Co., and the Institute for Research in Human Relations.

For a year, Cmdr. Hoover worked with Dr. Alex Williams of the University of Illinois studying such questions as: "How does man actually get the information he normally gets from the real world?"

"It turned out," Hoover said, "that we had to reproduce pretty much a facsimile of what the outside world looked like, although at that time we didn't have any idea of how we were going to implement this."

In his spare time he questioned every pilot he ran into to find out what information was needed in the cockpit. The surveys showed that the pilot requires answers to three questions: Where am I, and what am I doing? What should I do, and when? How am I doing?

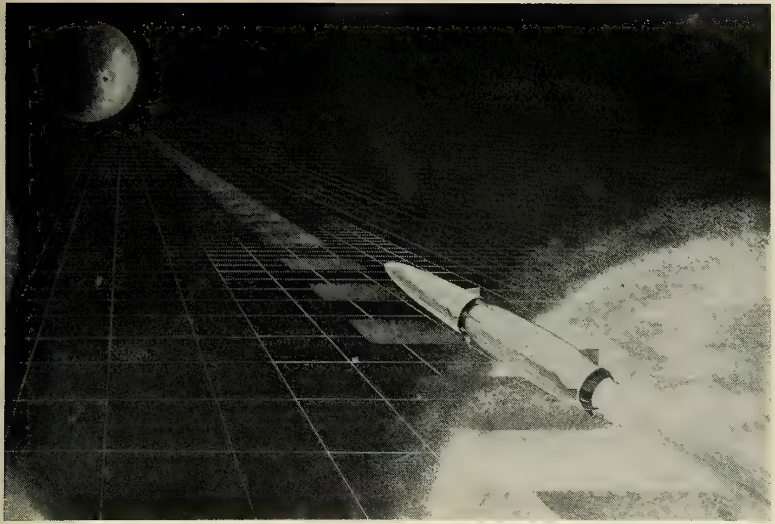
• **Seven-cue world**—Meanwhile, the Navy contracted with three human factors engineering firms and General Electric to make a study of various phases of the problem. On the question of reproducing inside the cockpit what was going on outside, GE, Dunlop and Associates, Deflores Engineering Co., and the Institute for Research in Human Relations came up with basically the same answer: "Man's world is made up of 14 cues with seven predominating."

These seven resulted in the contact analogue and, Hoover says, "We felt we had solved the problem of orientation."

From the first time the contact analogue was used in a simulator, even those who had never flown knew which way was up and were able to operate the trainer.

"If the controls were coordinated,

(Continued on page 79)



ONR development will give pilot constant orientation in his space environment

Highway to the Stars is More than Dream

by Cmdr. George Hoover*

In order to design a manned space vehicle we must first determine man's role in the overall man-machine complex. Is he to play an active or passive part in the operation?

Machines operate only because of specific man-made decisions. The most sophisticated automatic system requires man to impart intelligence to it, to start its operation, or to alter its program. Therefore, man's major role will be to make decisions, either in a passive or active capacity. Information must then be supplied to man in a form conducive to making decisions.

Decisions are made by exercising wisdom, and wisdom is knowledge of what is true or right coupled with just judgment as to action. Judgment is a critical evaluation of the facts at hand. It becomes apparent that correct or good decisions can be made only if all of the facts are at hand—and in a form acceptable to all of the human sensory systems.

• **Decision by Vision**—The visual sense is the most powerful because man has evolved in a visual world. Although it is essential that any visual input to man must be compatible with his other sensory systems, this discussion will be confined primarily to information displayed in visual form.

Since the manned space ship is a man-machine system, its effective performance is a product of both. If either is deficient, the performance of the system will be deficient. It is imperative, then, that reliability of the equipment and the design of the information display and controls be given prime consideration.

To determine any adequate display system it is necessary to first define the operations to be performed by the operator. In the space ship, the overall objective is essentially the same as for any transportation system—merely to go from point A to point B.

The total operation can be divided into several sub-goals such as launching or take-off, transition to orbit, orbit, departure from orbit, return to orbit, re-entry, and landing.

• **Flight modes**—The classical approach to space flight has been to assume that orbiting technique will be required with each flight, starting and ending with an orbit about the earth or other body in space. It is equally important to consider the possibility of direct flight without orbiting when the necessary means of propulsion is found. In this instance, the modes of flight would be much like those of ordinary aircraft.

Looking at each of the flight modes, the following is submitted as a partial list of information requirements. In addition to being divided into sub-goals, the information required is listed under three main categories of orientation, director, and quantitative. Man must know "what he is doing," "what he should be doing," and "how he is doing."

A comprehensive study of the total information requirements must be conducted to insure that the requirements are complete for every phase of flight

(Continued on page 21)

The 'Why' of This Story

For years many dedicated men have dreamed of sending man into the limitlessness of space. That dream is rapidly approaching the realm of reality.

First the power had to be developed. This has been achieved through the need of defensive military weapons—the banker for the space travel planners.

Next came the need for educating the populace to the value of placing man himself beyond the earth. This is being supplied because of prestige loss and anticipated military requirements.

In the meantime, planners such as Commander George Hoover have been busy preparing for the day when manned space flight will arrive. This article should help to convince the uninformed that man and the machine should be ready at the same time.

---

* *Manager, Weapons Systems, ONR.*

Bounce one off the moon

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space engineers weren'
equipped to bounce a missile o
the face of the moon. Toda
they're thinking far beyon
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and the fundamental requirements necessary to all space ship operators.

• **Operator interrogation**—Uncovering these fundamental requirements will require an unusual method of interrogation. Since there are no experienced "space pilots," we must draw from experienced aircraft pilots and submarine commanders the information necessary to perform space flight tasks.

For conditions which are not similar, we must extrapolate in terms of known operations. "Why" must be asked until the "why" questions the validity of the objective, or until the answer can stand unchallenged. This process, a tedious task, must be carefully carried out if the precise information is to be obtained.

As an example: A pilot will be asked what he would need to know for re-entry. His answer would probably be that he requires attitude information. When asked "why," he will probably say that he wants to know his attitude in order not to exceed limiting skin temperatures. Again when asked "why," he will probably state that if the skin temperature rises too high he will burn up.

Obviously this is his real concern and the attitude relative to the horizon will not solve his problem. In the first place, we would have to establish the attitude frame of reference. This would be the attitude relative to air density in order to maintain temperatures which can be dissipated. Attitude based on any vertical reference would not meet the requirement.

The inputs would be air density, rate of change of air density, actual temperature and rate of heat dissipation capability. In other words, attitude in this instance is relative to a variable path of feasible re-entry.

This is not the complete answer, but should serve as an example of the type of analysis that must be made to establish the fundamental information required.

• **Display requirements**—Once the information requirements have been established, the next step is to establish display requirements. Since man was born as an earth creature into a visual world, it is essential that his display conform to the patterns by which he originally learned to orient himself.

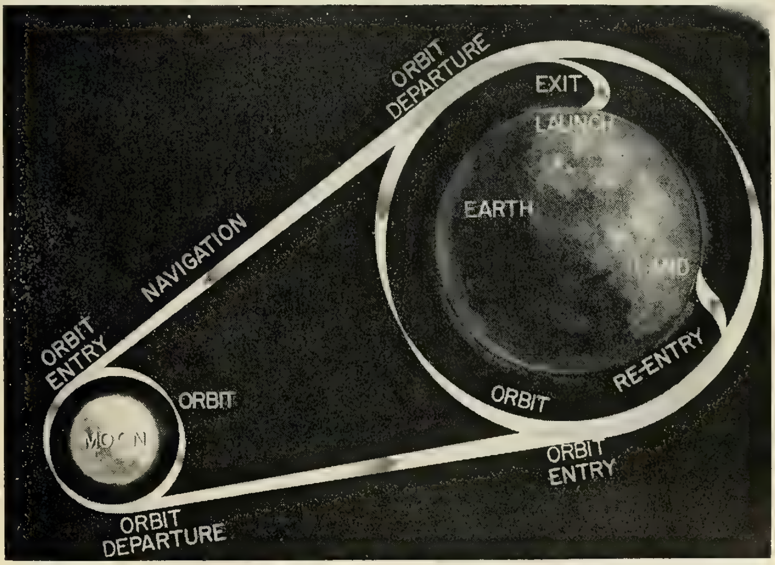
This would minimize any reconditioning of his reflexes when operating with the displays. Man's world consists primarily of a flat plane to which he orients himself by a set of visual cues.

One important visual cue is an **internal reference,** permitting the pilot to regard himself and his craft as a single unit. This reference normally is available to aircraft pilots in the form of a windshield. (In space, because of damage from meteoric particles, it may be necessary to utilize an electronic device for reproducing the actual outside view, with a viewing screen used in the same location as that of a windshield.)

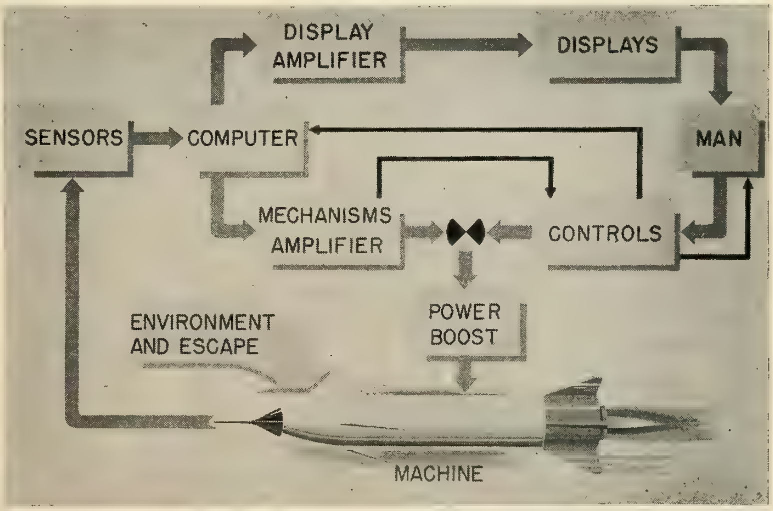
A second important visual cue is an **external reference.** The most common external reference is the horizon, which enables the pilot to determine the relationship of his aircraft to external objects or plane of reference.

This external reference will change depending on the particular plane of reference being used. It may be the earth's horizon, the plane of an orbit, or the plane of trajectory. It may also be the plane relative to a set of conditions such as described for re-entry.

In any event however, it must always *appear* to the pilot as his horizon, the reference with which he learned to orient himself. This information alone, often gives rise to misinterpretations. Parallel lines, apparently converging, represent **linear perspective,** helping the pilot to judge angular and altitude



THE TOTAL MAN operations divided into launching, transition to orbit, orbit, departure from orbit, return to orbit, re-entry and landing.



MAN-MACHINE SYSTEM—Essentially the same as for aircraft, the system becomes a marriage of the aircraft and submarine man-machine systems.

MISSILE ENGINEERING

The "collapsing of time" concept has taken on added significance as a result of the current international situation. In Tucson, Arizona, Hughes has established the Tucson Engineering Laboratory for the purpose of shortening the elapsed time between missile development and its effective tactical use. This activity, established over 2 years ago, has proven that the quasi-simultaneous development and production of missiles can become a feasible reality.

The Tucson Engineering Laboratory is now expanding its scope of operations. Mechanical Engineers, Electrical Engineers, or Physicists who like to work on urgent problems and who have the ability and enthusiasm to constantly improve the product and its reliability, will find this an ideal environment. Specific areas of interest include: missile system analysis, infrared and radar guidance systems, electromechanical and hydraulic control systems, missile and test equipment and electronic circuit design.

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changes. The texture of a reference surface is used by the pilot to determine slant of the surface, altitude, and distance.

This powerful visual cue is sufficient in itself to establish orientation without reference to the horizon. A textured surface representing the sky, composed of a distinctly different pattern from the ground pattern, provides orientation when the ground plane is not available.

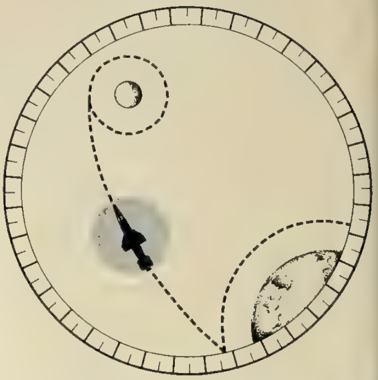
Movement over the surface results in an apparent distortion of the visual field, and this is known as **motion parallax.** Motion parallax provides a compelling cue to distance, speed, and direction of motion.

- **Contact analogue**—By integrating the visual cues abstracted from the real world, an artificial model can be created which for purposes of orientation is perceptibly equivalent to the real world. A display created from this model may be called a Contact Analogue.

Flying visually in space will be like flying on a black moonless night over uninhabited land or water. There will be no basis for orientation, no horizon, no ground reference, and no sky reference except a mass of stars in all directions.

Man will be subjected to a completely new environment, not only in its physical makeup, but new in the sense of having none of the basic cues and references by which man has learned to orient himself. Without an adequate set of references such as the Contact Analogue, he will be subjected to an awesome nightmare of helpless dis-orientation in an endless void.

Just as important is the need for recreating the basic cues of the visual earth world. In other words, the pilot must know "which way is up." Man must take along a little more of his environment in the form of a simu-



SITUATION DISPLAY—Such a display would show the earth, the destination, orbits, flight trajectory, etc., and the ship's position relative to flight plan.

Flight Mode Requirements

Flight Mode	Orientation	Director	Quantitative
Launch	Spatial Orientation	Direction of trajectory	Accuracy of position on trajectory Proper power Condition of ship and power plant
Transition to orbit	Spatial Orientation Situation display	Direction of trajectory Direction of thrust	Accuracy of position on trajectory Proper power Time of entry in orbit Condition of ship and power plant
Orbit	Spatial Orientation Position in orbit (Situation Display)	Direction of orbit Direction of thrust	Position on trajectory Position in orbit Proper power Condition of ship and power plant
Departure from orbit	Spatial Orientation Position in new trajectory	Direction of trajectory Direction of thrust	Proper power Fuel remaining (relative requirement for total trip) Position in trajectory

lated surface plane to supply the necessary inputs to his visual sense and add to his emotional stability. This plane would be the Contact Analogue.

In space flight, the line connecting these two points must lie in the simulated plane. Obviously, the paths of flight will be curved as will the planes, but since the distances are great, the plane will appear to be flat. The equations for establishing this theoretical plane will be established by the phase of flight being conducted at the time.

With such a display, man's basic orientation requirements will be met and space will become an extension of his natural habitat.

- **Simulated highway**—In space, even with the simulated plane, the real world does not contain any natural paths for man to follow. It is necessary then, to provide a theoretical path or means of providing direction information.

Studies for aircraft have indicated that the basic orientation cues are the elements with which a "highway" can be constructed to which man will react just as he does when driving a car down an ordinary road. It is this "highway" which will provide the necessary information to keep the pilot oriented and tell him what he should do in order to maintain his planned program.

Fed by the output of a computer solving the flight equations, the highway will show the operator whether he is high or low and right or left of the precomputed flight path.

In addition to the deviations, a set of markers along the highway moving at a predetermined velocity give the pilot his motion relative to the proper velocity along the trajectory. If the markers are moving with the craft, the correct velocity is being maintained.

If the markers are faster or slower than the craft, the velocity is too great or too little. Such a display gives the controller the same kind of information which he gets when passing other vehicles on a road.

The highway can provide more than just navigation information. As the computer solves the vehicle position within its operating envelope, the highway can be displaced in order that the operator can follow it to provide not only a safe margin within the envelope, but maximum utilization of his power at all times.

The highway can also show corrections to be made to maintain the proper trajectory. As an emergency device, the highway can be programmed by the computer to give the pilot a path to alter his flight plan, for instance, in order to return to earth as quickly and safely as possible.

Awareness of where the craft is

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relative to the plane helps to establish emotional stability, or "pilot tranquality." The highway, however, being in close proximity, gives the necessary cues for accurate changes in altitude, attitude and direction. Its rate of motion will be within the range of the pilot's capability to perceive changes and respond within his reaction time.

In other words, although the craft may be going thousands of miles per hour, the display will be such that the craft will appear to be moving over the highway at perhaps only 50 miles per hour.

• **Situation display**—In addition to the basic orientation and director display, the pilot must be provided with a separate indicator for situation display. This device will give the operator navigation information, cruise data, and information for flight planning.

Information concerning position of orbit with respect to earth and the objective in space, present position and heading, objectives or destinations, flight plan and fuel range remaining, could be integrated into such a display.

Information on the situation display would be long-term data giving the pilot his position relative to the total flight. Such a display would show the earth, the objective of destination, the orbit or orbits around each objective, the programmed flight trajectory, departure and re-entry paths, and the ship's position relative to the preplanned flight plan.

Quantitative information would be separate from the orientation and director displays. These displays would give such information as power, position in elevation relative to orbit or trajectory, ship condition, radiation level, temperature, pressure, and meteoric dust concentration.

These displays would give the desired or allowable limits as well as the actual condition, and in a way which would permit the operator to take positive action if required.

To achieve such a set of displays it will be necessary to conduct studies to determine the technical requirements for the system necessary to create the displays. Unnecessary redundancy and duplication in a space ship cannot be tolerated. Where alternate or standby elements are needed, additional units can be accepted, but reliability must be the paramount consideration in every part of the total system.

The effectiveness of the manned space ship will be a product of the man and machine. The man-machine system will be essentially the same as

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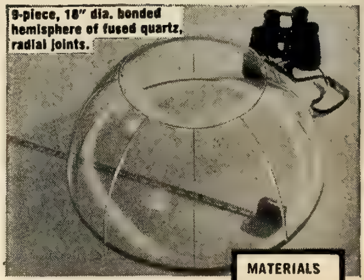
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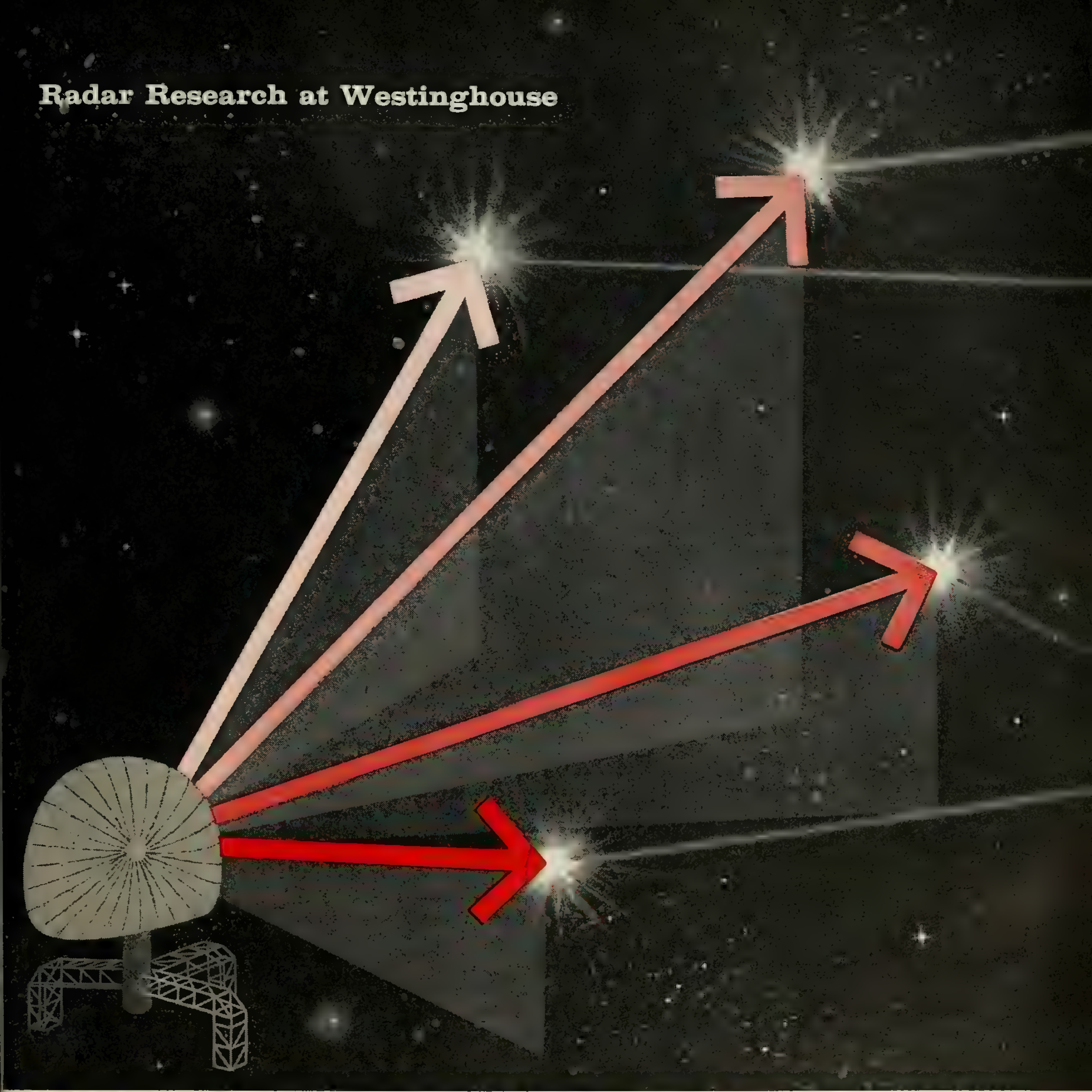

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for an aircraft, but with some of the additional requirements of environmental and damage control, and the necessity for maintaining habitability for relatively long periods of time. In this sense the system becomes a marriage of the aircraft and submarine man-machine systems.

• Sensor need—The sensors required will consist of electromagnetic and optical, inertial, force, geometric, quantitative, and chemical. Optical sensors will be used for fixing stars or other light sources such as the moon, earth, and planets to provide azimuth and altitude information to the computer to determine position in space.

This information will be supplemented by electromagnetic sensors for position computation, velocity in space, and detection of obstacles and space debris. Sensors similar to radar and doppler will be used for ranging and approach rates for orbit entry and landing.

Inertial sensors in the form of accelerometers and position storage devices will be used to supply information relative to changes in position which will aid in position computation, as well as deviations from the trajectory, and will supply information for flight-path control. They will further be used to maintain and control the gravitational state within the space ship.

Force sensors will be used to supply the computer with information for solving the control problem, cabin pressure, thrust, actuating systems, propulsive pressure, and servos.

Geometric sensors will provide information to the computer regarding thrust alignment, direction of auxiliary control jets, azimuth and declination of telescopes for tracking, and other angular measurements.

Chemical sensors will continually analyze the air composition and supply the computer with data for controlling the environment.

Quantitative data such as quantity of fuel, quantity of air, food, temperature, radiation, coolants, etc., will be provided to the computer for proper processing into the various equations.

The computation for the space ship will be accomplished by a central computer capable of continuously solving all of the equations for all systems such as data presentation, ecological control, flight control, communications.

Such a computer will probably be digital, with parallel logic processing. It must be reliable, with built in essential redundancy and self-healing capability. It will include high capacity memory circuits, high speed computation capability, flexibility, and will probably employ micro-circuitry utilizing solid state techniques to permit maximum capacity.

Much research and development must be carried out before man first launches himself into space. With proper analysis it becomes obvious that since the objective is to put man into space, as a decision maker he must be given the proper information and displays in order to most effectively make these decisions.

But to do this, the space ship must provide him with a proper decision-making environment, the necessary sensors, a central control computer, and the proper controls to carry out his tasks.

With these as necessary parts of the total man-machine system and an integrated adequate display, man will soon be crossing the vast frontier of space by taking his space ship along the highways to the stars.

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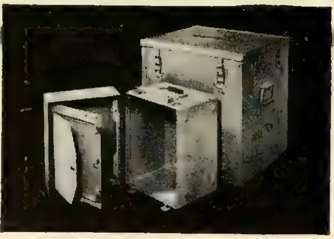

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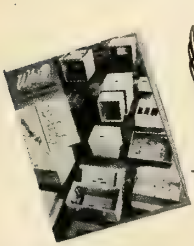

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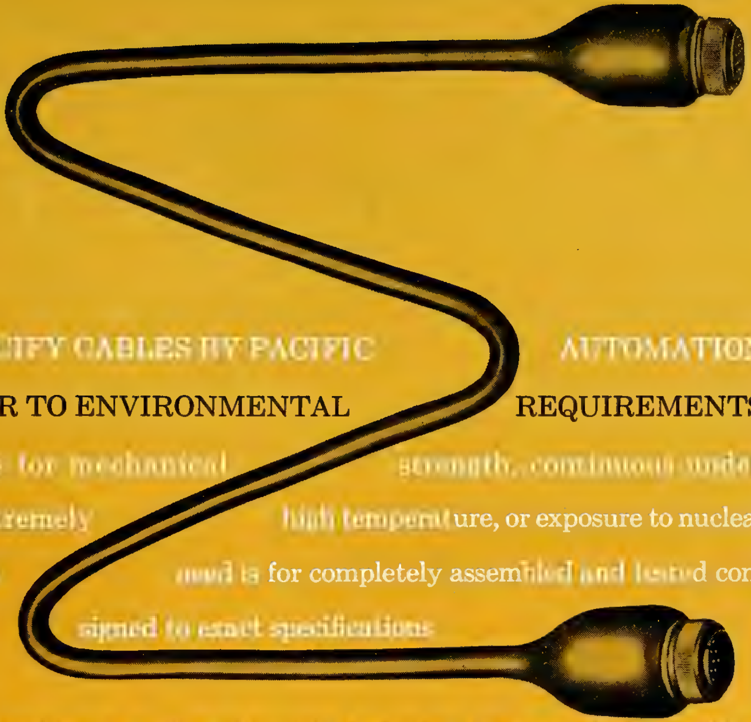

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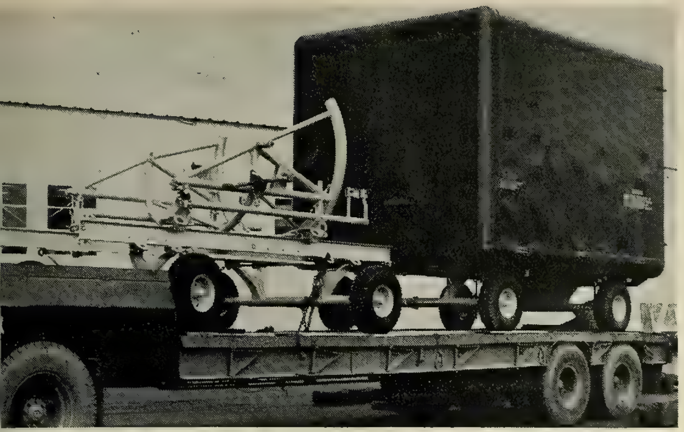


Two-year development program gives Air Force transport capability for IRBM/ICBM components

Missile Trailer Provides Universal Handling

by Norman L. Baker

The Air Force, after a two year levelopment program, has achieved an ir transportability truck transport sys-em for operational IRBM/ICBM quipment.

The new universal handling and ransportation system, developed by he Air Logistics Corp., is built around lightweight-covered trailer incorporat-ng novel loading and unloading capa-ilities. Only four units are required to neet Air Force requirements for trans-orting all ballistic missile propulsion omponents.

The Mobil-Tainer trailer system in-ludes a model for the *Titan* booster ngine and the *Thor* main propulsion init; a model for the *Titan* and *Atlas* ustainer engine, the *Atlas* booster hrust chamber and the *Atlas* booster ower package; a transportation trailer; nd a standard Air Force workstand railer. Without modification, the quipment can be used for transporting anks, nose cones and ducting.

As the result of preliminary investigations at the outset of the pro-ram, it was found feasible to develop universal transportation capability ising the standard Air Force trailer quipment. Results of the investigation vere later deemed inconclusive and Air Force had to invite various con-ractors to propose a set of criteria and equirements.

The problem laid out by the Air Force was the transportation, handling nd storage of various ballistic missile ropulsion system components using tandard Air Force and/or other gov-rnment agency and/or commercial quipment.

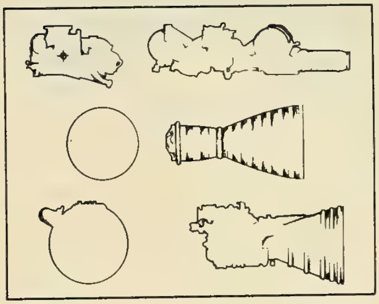
This problem was complicated be-ause the liquid rocket type propulsion system components in the IRBM and ICBM weapon systems are large-volume, low-density, asymmetrically shaped, fragile units which vary in size, form and construction for each system or component. (Illustrations of the package envelopes for these missile systems accompany this article.)

• **Study results**—Early results of this study indicated that the best approach was to design the equipment around the propulsion system components. Minimization of the weight and cost of the system was the next objective of study.

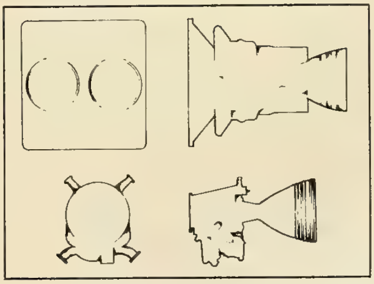
This predetermined optimum system consisted of a universal chassis designed to accommodate a large or small "bed" and cover for the various components. The system designed by Air Logistics and selected by the proposal evaluation committee, included a large bed and cover for the *Titan* booster engine and the *Thor* main engine and a small bed and cover for the *Titan* and *Atlas* sustainer engine and *Atlas* boost, thrust and power package.

The entire program was accomplished in a little over 12 months. This included formulations of basic criteria, submittal to design proposals, evaluation of proposals, awarding of contracts, initiation of system engineering and detail design, establishment of manufacturing facility, development of fabrication techniques, testing, delivery of units on schedule and placement into operational use.

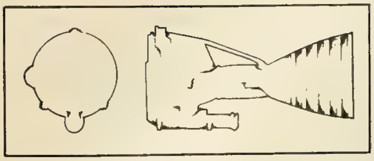
The low weight of the system, dictated by air transportation requirements, was made possible by development of a fibreglass aggregate, called Paraglas. The material is particularly resistant to dents, abrasions, cracking,



WS 107A SM-65 *Atlas* engine envelopes —XLR 93-NA-1 Booster Power Package (Top); XLR 93-NA-1 Booster Thrust Chamber (Center); XLR 105-NA-1 Sustainer (Bottom)



WS 107A2 SM-68 *Titan* engine envelopes —XLR 87-AJ-1 Booster (Top); XLR 91-AJ-1 Sustainer (Bottom)



WS 315 A SM-75 *Thor* engine envelope —XLR 79-NA-1 Sustainer.

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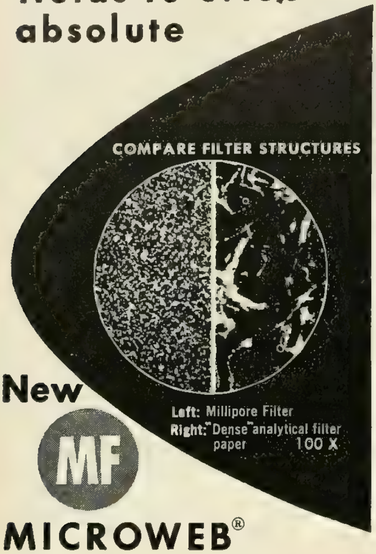
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weathering, synthetic lubricants, fungus, rodents and insects, and appears to meet all flexibility requirements.

Flexibility of the system was a major factor in the determination to eliminate shock mounts, an unheard of decision at the time. Tests utilizing accelerometers mounted in the trailers proved that shock mounts were not required.

Based on this abbreviated test program, shipment of production MB-3 *Thor* engines was authorized from the Rocketdyne plant in Neosho, Mo. to the Douglas factory in California. Accelerometers mounted aboard for the first trips indicated the vibrations did not exceed the specification requirements.

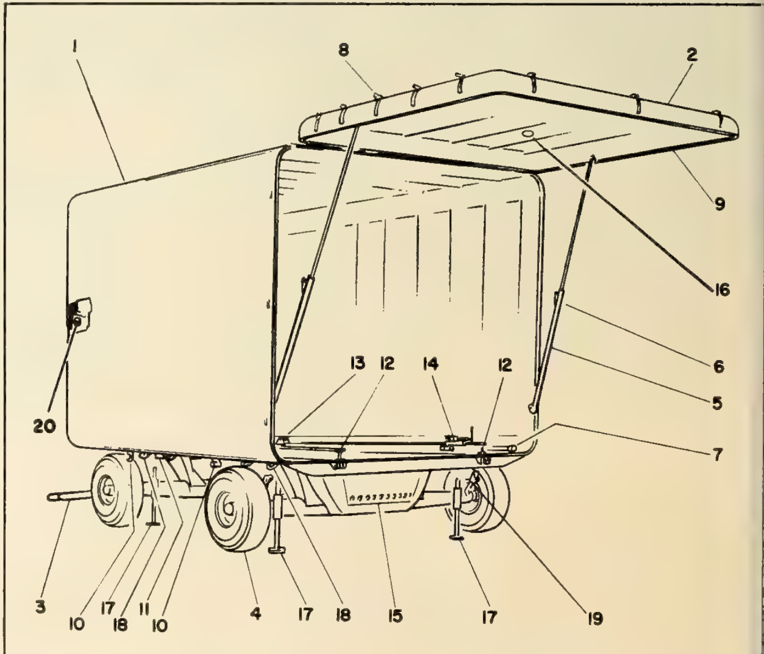
• **Capability**—The propulsion components in a Mobil-Tainer can be transported in a C-124 aircraft or on a commercial flat-bed truck. The seven major propulsion components are carried in two vehicles. Normally six different containers would be required.

In addition, the system is capable of accommodating vernier engines, tanks and loose ducting which was not possible with other containers. Trailers are designed for easy accessibility to the components for maintenance and check-out tests.

The universal system is not only applicable to the propulsion systems but to re-entry vehicles or nose cones as well. This standardization of the system for hauling nose and aft ends of the missile systems makes it a high priority item in the Air Force ground support system.

The development of this universal transportation, handling, and storage system for ballistic missile components is monitored by the Propulsion Division of AFBMD and the propulsion group of the Space Technology Labs of the Ramo-Wooldridge Corp. However, each weapons system office, the Strategic Air Command and the Air Force Ballistic Missile Office are all concerned in the successful execution of the program.

All of the weapons systems are not at the same stage of development. Some are in the production phase, some are in the research and development phase. With the development of engine, missile and GSE for these systems considerable success has reportedly been achieved in adapting this universal system to both ends of the missile systems.



GENERAL CONFIGURATION of engine system trailer—1) Container; 2) Container access door; 3) Towbar; 4) Wheels; 5) Telescoping strut; 6) Latch mechanism; 7) Door pole; 8) External clamps; 9) Seal; 10) Towbar storage brackets; 11) Records container; 12) Rail assembly; 13) Fixed adapter stop; 14) Adjustable adapter stop; 15) Desiccant chamber; 16) Humidity indicator; 17) Jack; 18) Tie-down fittings; 19) Parking brakes; 20) Purge fitting.

Plant Opened

Callery Chemical Ready For Boron Production

by Alfred J. Zaehringer

Muskogee, Okla.—Boron "exotic" fuels, which in the past have been items of laboratory curiosity, will soon enter the realm of a tonnage chemical here early next year.

In the meantime, Callery Chemical Company is putting the finishing touches on its $38 million high-energy fuel plant which it will operate for the Navy. The plant, dedicated November 1, will provide many times the production capacity of any known boron fuel plant. Until now, only small quantities of boron hydrides have been available for evaluation in various types of propulsion systems such as turbojets or ramjets.

About two years ago, Callery broke ground on this plant, primarily located here because it offered a cheap source of raw materials and power—both from natural gas. This is because it akes a lot of power to rearrange the oron-hydrogen-and-carbon atoms to form the "Zip" fuel.

An indication of the power requirements for the plant can be gleaned rom the fact that although the plant ayout is significantly smaller than a onventional refinery, the steam plant s nearly 25 times larger than the steam lant in a petroleum refinery of comarable size. This is where the energy omes from—creation of compounds vith higher potential chemical energy. Though Callery has not named its omposition, it is felt that the "fuel of he future" is an alkylated boron hyride. A good guess is that the alkyl roup in the fuel is an ethyl.

•**Chemical**—Primary raw chemials are boric acid (shipped in from alifornia's Mojave) and sodium metal vhich are reacted to form the sodium orohydride. Ethyl alcohol is dehyrated to form ethylene—presumably or the alkylation process.

Nobody will talk about the next hase, but it is generally figured that he borohydride is reacted with boron rifluoride or trichloride to form diornae. It is significant that both Metl Hydrides, Inc., Beverly, Mass., and tauffer Chemical Co. have maintained lose liaison with Callery. Both firms urn out the boron intermediate. Either vay, Callery admits that it turns out iborane and has publicly disclosed atents for this process.

Next step comes in the alkylation f the primary diborane. Purpose is to mpart more suitable physical properies to the boron hydride—particularly

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. . . Callery readies boron

boiling point and density (The density of Hi-Cal is quite near that of ordinary JP-4, m/r learned from Dr. W. H. Schechter, vice president of operations for Callery.)

• **Skeptical on cost**—According to official Air Force sources here, it is not visualized that the boron fuels will eventually ever get to the $1/lb category even with large scale production at some distant date. Statements of Olin Mathieson (Olin operates the Air Force boron fuel plant) about boron fuels getting down in price to $1/gal are regarded here with a great deal of scepticism. At best, all the production of the boron fuels for some time to come will be used for turbojets (the chemical bombers) with some trickling down to select prototype ramjets.

As far as is known, though offering theoretical gains for rockets, other fuels (such as the hydrazines) will outstrip borons for rocket and outer space use. Dr. Schechter, together with Callery's working association with Thiokol are, however, swinging around to the belief that boron hydrides may have a big future in solid propellant rockets.

The Muskogee plant has four processing units located on 300 acres of a 1300 acre site. Among the larger units is the $3.5 million gas plant which produces hydrogen, carbon dioxide, and nitrogen. The nitrogen is used extensively through the plant to provide an inert and protective blanket of gas.

The lower boron hydrides and possibly the intermediates react quite rapidly with the oxygen in the air. For this reason, the plan is laid out according to quantity-distance practices established for the explosive industry.

It is interesting that Mine Safety Appliances, a Callery affiliate, has extensively equipped the plant with chemical fire fighting equipment, protective equipment for plant personnel, and rescue apparatus. Another affiliate, Gulf Oil Co., is also providing processing and administrative know-how.

• **Other facilities**—In addition to the Muskogee plant, Callery also operates a Hi-Cal plant at Lawrence, Kansas, and has administrative and technical centers at Callery, Pa. and Pittsburgh. Recently established with Callery is a liaison representative at Wright-Patterson, formerly with Ballistic Missiles Division.

Total employment at the Muskogee plant will be about 500. Only a small group of technical supervisory personnel was transferred to Muskogee from Callery's Research and Development Laboratories at Callery to provide a nucleus for management and operation of the new plant. Most of the operating personnel are Muskogee area residents whose training and education are especially adaptable to the supplementary training program which Callery has conducted for employees.

"Project Zip" was conceived by the Bureau of Aeronautics five years ago to provide a new fuel which would enable Navy jet planes and air-breathing missiles to fly further and faster with greater payloads.

• **BuAer funds** — The Industrial Planning Division of BuAer provided funds for construction of the plant with administration under the direction of the General Representative, Central District, BuAer. The Kansas City BuAer representative has been directly responsible for contract administration. The Bureau of Yards and Docks has been the authorized representative of BuAer on plant construction, with direct supervision under the Public Works Officer, Eighth Naval District, New Orleans.

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missile people

Appointment of **Brig. Gen. Monro MacCloskey,** USAF (ret.), as assistant to the president, Crosley Division, Avco Manufacturing Corp. was announced recently. Before retiring from the Air Force in June 1957, Gen. MacCloskey was commander of the 28th Air Division (Defense) at Hamilton Air Force Base, Calif. Past assignments include posts as U.S. Air Attache in Paris, and Commander of the Air Resupply and Communications Service, Military Air Transport Service.

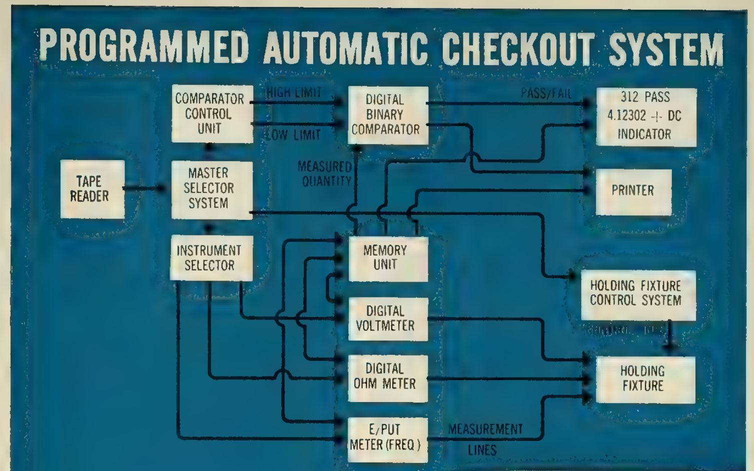
Col. Benjamin G. Holzman, has been named Commander of ARDC's Air Force Office of Scientific Research (AFOSR) replacing **Brig. Gen. H. F. Gregory,** retired. He was assigned to the Directorate of Research and Development at USAF Hq. from 1947 through 1950 with R&D duties in basic science and atomic energy. During this period he was the meteorologist for the first atomic test in New Mexico and served as staff officer for the 1946 and 1948 atomic tests in the Pacific. In 1955 Holzman became Director of Air Weapons at ARDC Hq. and Director of Research in 1957.

A realignment of the organizational structure of the General Electric Co.'s Missile and Space Vehicle Department has been announced. The following new sections will be coordinated with existing sections to function as a unit.

The re-entry vehicle project operation will be headed up by **Mark Morton;** the space vehicle project operation will be managed by **Howard M. Wittner.** These will work closely with the missile production section, at Burlington, Vt., the aerosciences laboratory and the quality control and test operation.

Flight Sciences Laboratory, Inc., announced these appointments: **Dr. Joel S. Isenberg,** technical director and **Dr. Kenneth Pearce, Fred S. Roehrs** and **Robert J. Whalen,** principal scientists.

A new organization designated Weapon Systems has been established at the Douglas Aircraft Co. **Charles R. Able,** former head of Military Sales, was named director "to strengthen the management and direction of company military programs and to meet the challenge of increased competition." Weapon Systems will include the department previously known as Military Sales and will develop integrated plans for future military programs and coordinate their emplementation.



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Automatic Testing Cuts Costs

by Norman L. Baker

Missile test equipment for heavy flow manufacturing, long a laborious production bottleneck, has moved to an "honorable" position at the end of the assembly line. Hughes Aircraft Co. is currently saving thousands of dollars each month in its *Falcon* air-to-air missile production program by utilizing automatic assembly line test equipment.

The test device, apparently the first in the country, is known as the Aircraft Missile Weight and Balancing System. Designed and built by the Electronics and Instrumentation Division of the Baldwin-Lima-Hamilton Corp., the equipment determines the center of gravity and thrust alignment of the *Falcon* directly with extreme accuracy.

The system assesses each missile by certain pre-set standards for weight, longitudinal CG, lateral CG and thrust alignment. Measurements are recorded automatically on a paper called a Weight and Alignment Data Chart. Consisting of two major units, the equipment performs the following operations:

1) Measures the weight of the missile (accuracy of 0.1016).

2) Determines longitudinal CG (accuracy of .015).

3) Determines lateral CG (accuracy of .002).

4) Measures thrust alignment (accuracy of .002).

5) Repeats measurements on missile (accuracy of .0005).

All the above measurements are completed in about five minutes.

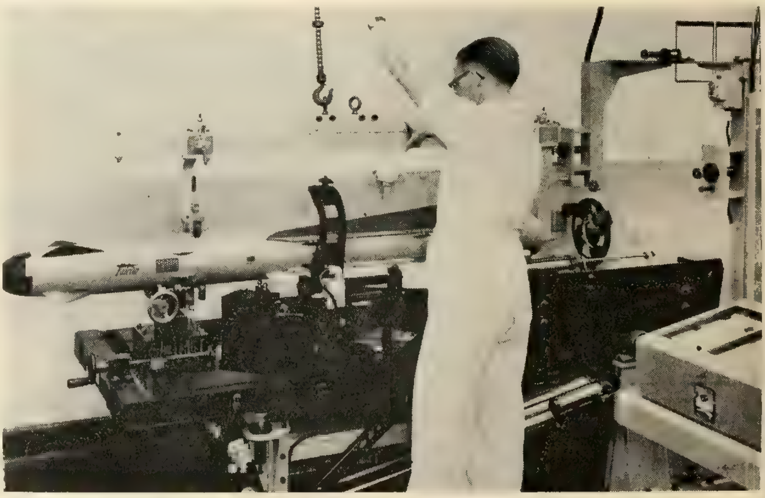
Prior to installation of the new equipment, the *Falcons* were checked out by mechanical test apparatus. The quality control instrument was realized by development of two radical sensing elements and a standard load cell.

• Systems Operation—As the *Falcon* leaves the production assembly line, an overhead monorail picks up the missile and lowers it horizontally by hoist onto the test platform. It is aligned on the platform by a pin which fits into a tooling hole in the missile.

After the *Falcon* has been lined up horizontally, the operator presses a button on an adjoining electronic console, lowering the missile on a cradle mounted on a load cell which weighs it. The operator then turns the manual programming switch to a set position measuring the longitudinal CG which is printed on a chart. The switch is a large metal disc that permits the operating buttons to be pressed only in the correct sequence.

Following the longitudinal CG and weight recording on the chart, the data is removed from the printer and placed in a plotter for recording the lateral CG and thrust alignment. Two measurements, made while the missile is still in its horizontal position, determine the lateral CG.

An initial measurement—lateral CG "X"—is made. The missile is then rotated 90 degrees around its long axis, and a second measurement—lateral CG "Y"—is made. The summation of these two readings are recorded as the lateral CG reading.



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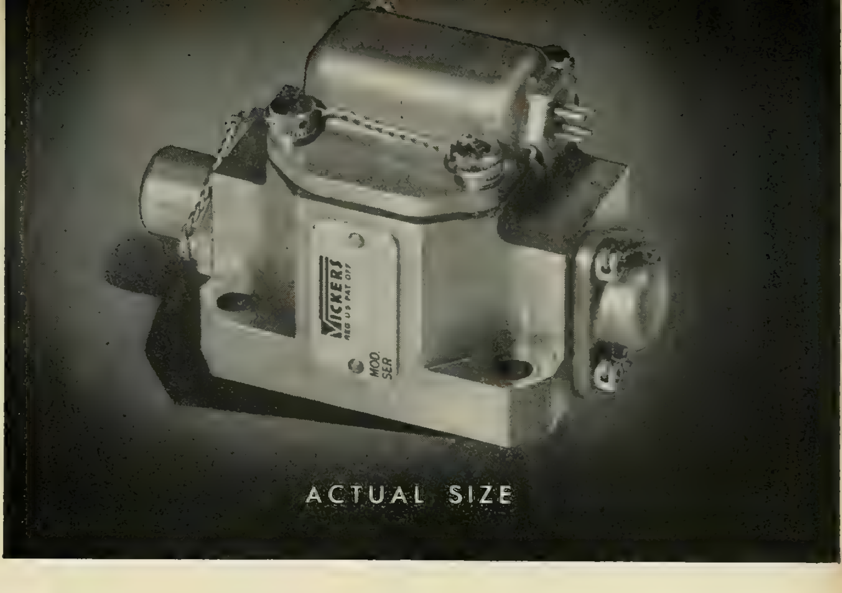

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when and where

NOVEMBER

American Society for Quality Conference, Sixth Annual Aircraft and Missile Division Conference, Biltmore Hotel, Dayton, Nov. 17-18.

American Rocket Society, 13th Annual Meeting and Astronautical Exposition, Hotel Statler, New York, N.Y., Nov. 17-21.

Eighth National Plastics Exposition, International Amphitheatre and Plastics Conference, Hotel Morrison, Chicago, Ill., Nov. 17-21.

Northeast Electronics Research and Engineering Meeting, Mechanics Hall, Boston, Mass., Nov. 19-20.

Lockheed Missile Systems Division's Research Laboratory, Third Symposium on Magnetohydrodynamics, Palo Alto, Calif., Attendance by invitation, Nov. 21-22.

The Convertible Aircraft Congress, Franklin Institute, Philadelphia, Nov. 28.

First Electronic Computer Exhibition and Symposium, Olympia, London, England, Nov. 28-Dec. 4.

DECEMBER

Third EIA Conference, Reliable Electrical Connections, Dallas, Texas, Dec. 2-4.

IRE and AIEE, Second National Symposium on Global Communications, Colonial Inn, St. Petersburg, Fla., Dec. 3-5.

Eastern Joint Computer Conference and Exhibit, Bellevue-Stratford Hotel, Philadelphia, Penna., Dec. 3-5.

Mid-American Electronics Convention, sponsored by Kansas City Section, Institute of Radio Engineers, Municipal Auditorium Arena, Kansas City, Mo., Dec. 9-11.

American Astronautical Society, Fifth Annual Meeting, Hotel Statler, Washington, D.C., Meeting will be held in conjunction with the 125th Annual Meeting of the American Assn. for the Advancement of Science, Dec. 27-30.

JANUARY

Fifth National Symposium on Reliability and Quality Control in Electronics, Bellevue-Stratford Hotel, Philadelphia, Penna., Jan. 12-14.

Society of Plastics Engineers, 15th Annual Technical Conference, Hotel Commodore, New York, N.Y.

MARCH

IRE, AIEE and Association for Computing Machinery, 1959 Western Joint Computer Conference, Fairmont Hotel, San Francisco, Calif., March 3-5.

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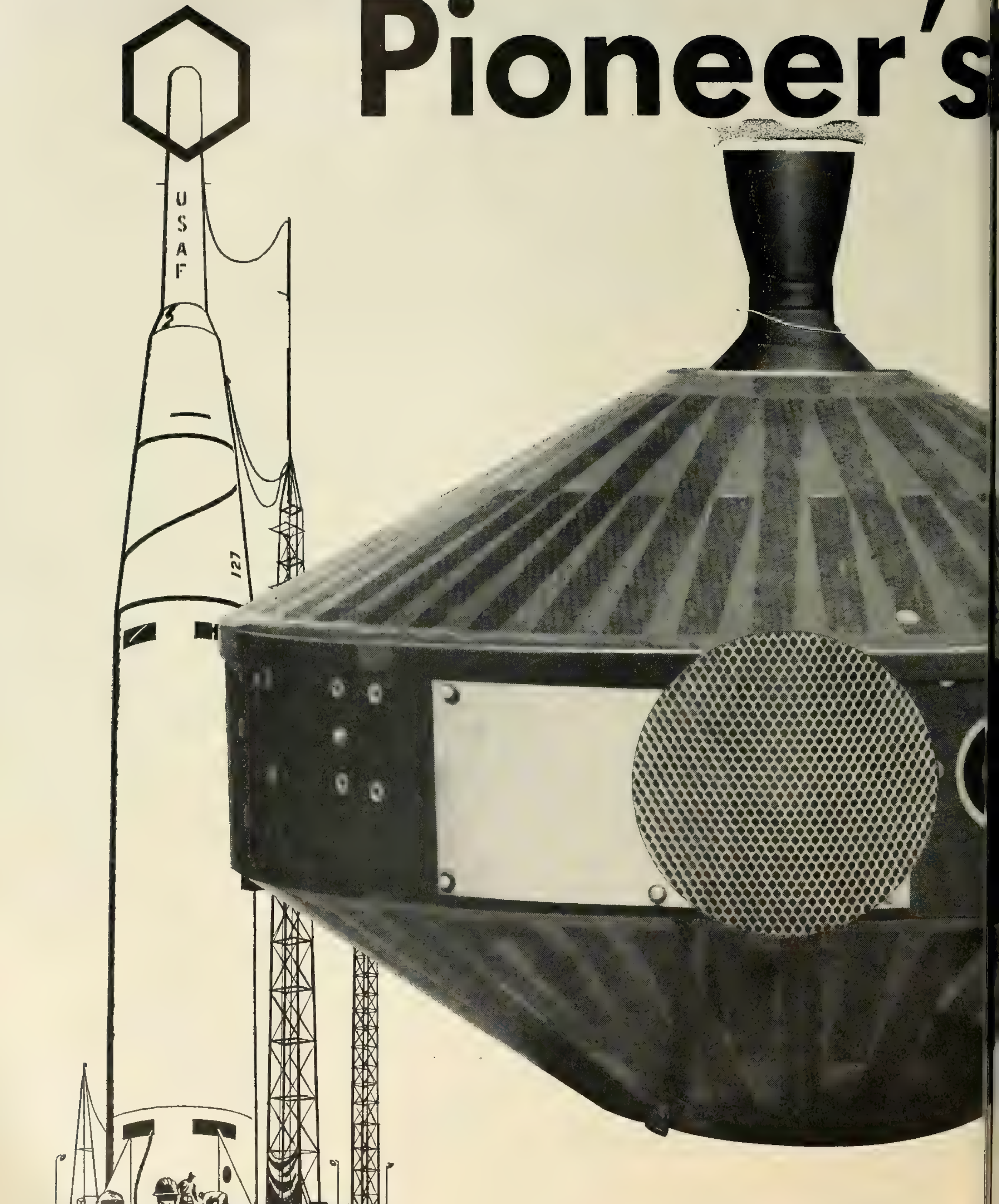
Pioneer's



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DATA PROCESSING SYSTEM SPECIALISTS

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A missile comes "of age"—reaches operational status—as a result of many influences. Vital among these influences is the rapid incorporation in the test vehicle of modifications required by evaluation of flight performances. The faster these modifications are made, tested, and become incorporated in the design the faster the vehicle is declared operational.

The completion of this cycle is dependent too upon the speed with which vast amounts of test data can be reduced, analyzed, evaluated, and reported to the military and to the cognizant weapon systems contractors.

So, with the advent of missiles has come a revolution in data processing techniques—a revolution in which the Engineering Services of Telecomputing Corporation has been highly successful in greatly reducing the elapsed time for complete processing of missile flight test data.

This is an invitation to join the data processing specialists who comprise the Engineering Services Staff—a Staff which establishes the state-of-the-art in data processing techniques and methods as we go about our job of computing the performance of missiles under test at the White Sands Missile Range.

Join us and work with high speed digital computers and other modern data processing equipment in reducing the test data from scientific data measuring systems such as, cinetheodolites, electronic measuring systems, precision optics, and telemetering systems.

Join us—and grow with us—as our advanced processing techniques are employed in this fascinating field of missile flight testing so important to our national defense effort.

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space age

by Norman L. Baker

The unexpected discovery of the high altitude radiation belt, with the resultant concern for future manned space travel, has almost overshadowed the other invaluable findings made by the *Explorer* satellites. First, micrometeorite impact detectors have substantiated beliefs that these small particles will not offer a hazard to space vehicle structures. Temperature measurements have shown that the environment of a space cabin can be controlled to a comfortable level by proper selection and proportion of exterior radiating materials. It is known, for instance, that the density of the atmosphere at 200 to 300 kilometers is about 40% higher than was originally anticipated.

Precise tracking of the satellites has also given a more accurate profile of the earth's sphere. It is apparently ½ to 1% less curved than previously thought. Irregularities in the satellites' velocities indicate enormous air mountains which are constantly changing due to the sun's radiation.

The nuclear power space programs, Project Rover and Project Snap, are reporting excellent progress and confidence for an early development breakthrough is exceedingly high. Project Rover will use a solid-fuel nuclear reactor to heat a light propellant-like hydrogen to extremely high exhaust velocities.

First rocket reactor will probably be a graphite core loaded with uranium and surrounded by a beryllium oxide reflector. Hydrogen will be drawn through the reactor, undergo tremendous expansion and then move out through the nozzle. Temperatures in the reactor will be in the 4,000 to 5,000°F range.

The development of an auxiliary nuclear power source for satellites, Project Snap, is actually three programs. *Snap I* is the use of radioactive isotopes as a heat source with Martin as the prime contractor. Cerium 144 is being used as the heat source. *Snap II* is an Atomics International thermal reactor. *Snap III,* a project by Westinghouse, is an extremely small power source—weight less than 10 pounds, but will develop three watts of electrical energy for six months.

Major breakthrough in storable liquid packages may soon make these units available for space vehicles. Reaction Motors has successfully tested a 50 k package for 5.7 seconds. Unit was scaled-up from the *Bullpup Guardian* engine. This size package should be ideal for a second stage section of a *Thor-Able*-type of vehicle. The storable liquid package rocket had its beginning in World War II with the German *Taifun* surface-to-air rocket.

Controlled nuclear explosions for space-propulsion power is under investigation by General Dynamics Corp's General Atomics Division. General Atomics study differs from others because it uses a series of controlled detonations for power within the atmosphere and beyond.

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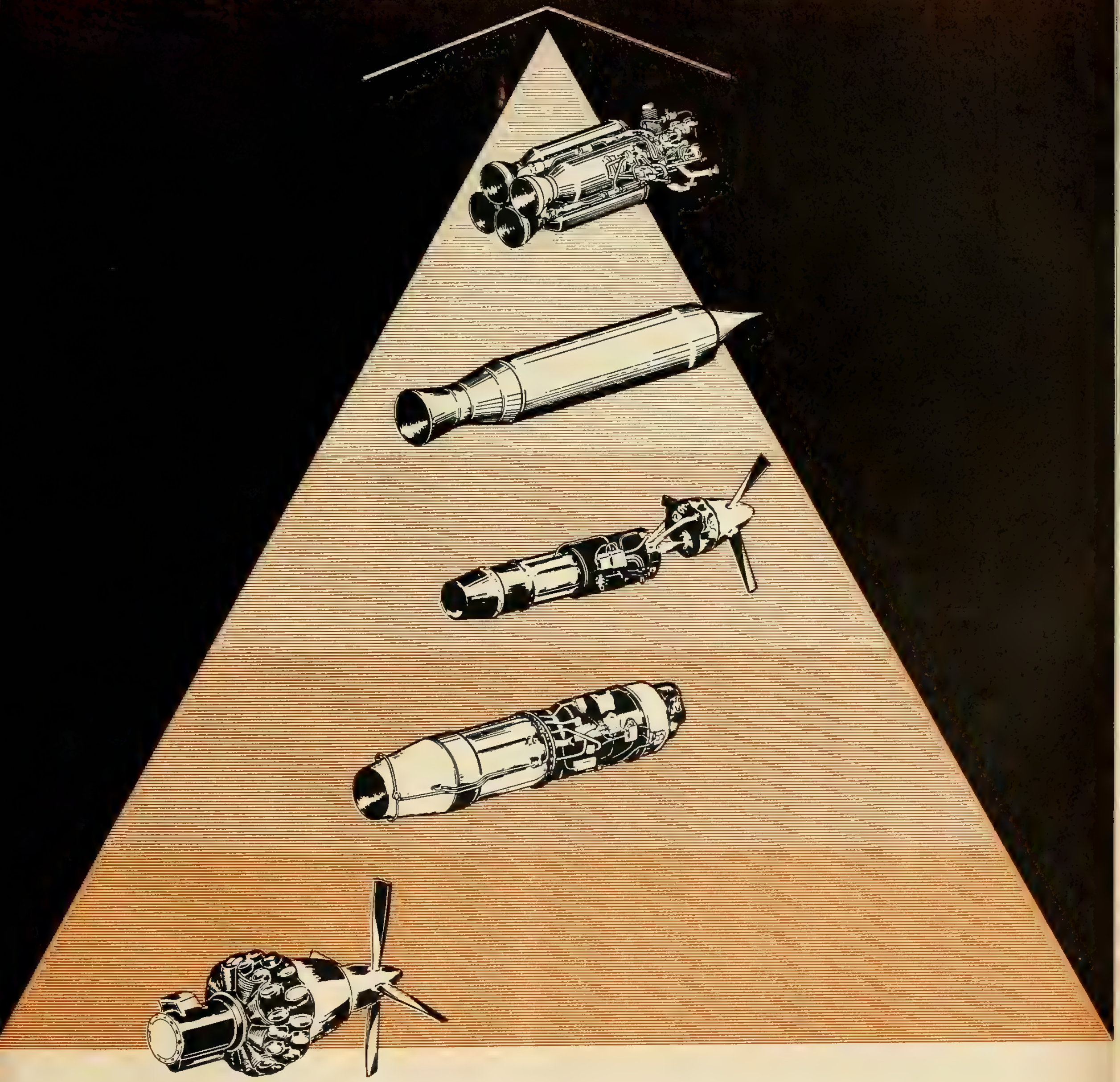

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Rubber and plastics fabricators need faster curing systems. The use of more active agents for rapid curing reactions has been restricted, because their use generally results in formulations difficult to process and store. This problem is serious at the high temperatures reached during the processing of rubber formulations. A novel series of latent curing aids, called Linde Chemical-Loaded Molecular Sieves, now make it possible to use these active compounds to obtain faster, more effective curing systems, while still maintaining processing safety.

In Linde Chemical-Loaded Molecular Sieves curing aids are "locked" within the pore structure of the Molecular Sieves by strong adsorptive forces. The active compounds, when loaded on Molecular Sieves, are effectively isolated from the rubber or resin formulation during processing and storage. However, at curing temperatures, which are generally higher than processing temperatures, the active compound is released from the Molecular Sieve to accelerate the curing reaction.

In this way, Loaded Molecular Sieves permit the use of highly active compounds to obtain fast cures, without sacrificing processing safety or pot life. Now, even vulcanization agents previously considered too active or volatile for practical use, may be used with processing safety.

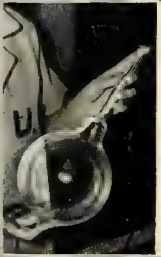
Chemical-Loaded Molecular Sieves can be used as latent accelerators and curing agents in a variety of rubber and plastics formulations including styrene-butadiene rubber, natural rubber, Neoprene, nitrile rubber, epoxy resins, rigid vinyl plastisols and others. Loaded Molecular Sieve CW-2015 (di-tertiary butyl peroxide) is being used commercially in the curing of silicone elastomers and rigid vinyl plastisols. Loaded Molecular Sieves are now being investigated by many processors of rubber and plastics in such items as tires, mechanical goods, hose, belting and footwear. For further data, write to Molecular Sieves Department 0000, Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

Radioactive Krypton

Krypton 85 is a radioactive isotope of the inert atmospheric gas, with a half-life of 9.4 years.

Radioisotopes such as Kr-85 are relatively inexpensive and new uses for them are being found every day.

One application is in tracer element testing of hermetically sealed encapsulated transistor devices. Another is in an "external" non-electric illuminating lamp which uses Kr-85 to activate a phosphor coating on the inside of a glass globe. Studies at the National Institutes of Health have shown that Kr-85 can be used to detect abnormal heart openings. 99 per cent of Kr-85 radiation is non-penetrating, quite safe, even for repeated exposures.



Linde is marketing Kr-85 as an additive to non-radioactive rare gases (argon, helium, neon, krypton and xenon) individually or as mixtures. Linde does not sell Kr-85 in pure or concentrated form. The other rare or inert gases, with Kr-85 added, will normally be available only in Atomic Energy Commission-approved, specially-marked cylinders.

Purchasers must be licensed by local or regional A.E.C. offices except for purchases of one microcurie or less. Non-licensed purchasers of one microcurie each may have 10 such cylinders on hand at a time.

Linde's price for Kr-85 additions will be based on the radioactive level of the gas mixture expressed in millicuries of activity (N.T.P.) per liter. For additional information, write to Rare Gas Department 0000, Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

Three-Level Ruby Maser

The Maser is a microwave amplifier utilizing energy stored in a molecular or atomic system. Emission of this energy is stimulated by the input signal. Masers operate at liquid helium temperatures and have incredibly low noise levels approaching zero db. Recently a University research laboratory* used Linde single crystal synthetic ruby (Al$_2$O$_3$ with Cr$_2$O$_3$ additive) in a three-level solid state Maser. The ruby crystal was placed at the center of the Maser's tuned cavity and a magnetic field of 4200 gauss was applied. To bring electrons from a ground state into a permissible higher energy level, a pumping frequency of 24 kMc was used and the Maser successfully amplified signals at 9.3 kMc.

Linde also supplies other crystals including rutile, spinel and sapphire (Al$_2$O$_3$). Sapphire is used in infrared optical systems, windows for high power microwave tubes, spacers and supports in vacuum tubes, radiation pipes. It has strength at elevated temperatures, melts at 2040°C, is hard, inert, nonporous and can be sealed to metals and glasses. Sapphire is currently available in the shape of domes, windows up to 4½ inches in diameter, rods and special configurations.

For further data write to Crystal Products Department MI113, Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, New York.

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*"Maser Action in Ruby," by G. Makhov, C. Kikuchi, J. Lambe, and R. W. Terhune. "Physical Review," Volume 109, Number 4, Page 1399, Feb. 15, 1958.

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keeping track

by Peer Fossen

Things are really being rushed to complete the Goldstone Tracking Facility at Camp Irwin, Calif., in time for Army's first lunar by-pass shot. Construction crews have for some time been working seven days a week in two 10-hour shifts per day. The project, which was started in July, is under Jet Propulsion Laboratory's supervision and includes the following principal contractors: The Blaw-Knox Co., Pittsburgh, Pa., Radio Construction Co., Pittsburgh, Pa., Collins Radio Co., Cedar Rapids, Iowa, and the Rucker Co., Oakland, Calif.

Principal component of the Goldstone Tracking Facility is an 85-foot in diameter, 110-foot high parabolic antenna, focusing received radio waves to a point where the pick-up antenna or a radio receiver is located. The all-steel dish has an east/west declination angle of 180° and slightly less—160°—for north/south tracking. When put into operation the antenna will be capable of receiving signals from space vehicles up to 400,000 miles distant. By increasing antenna efficiencies as well as the power and size of the transmitters in space, tracking range could be extended to 40,000,000 miles by 1960 and to 4,000,000,000 by 1962.

University of Michigan's ruby maser (m/r October 6, p. 25) is being fitted into the plans for the 85-foot radio telescope under construction by the University at Peach Mountain, near Dexter. In the ruby maser, which operates at temperatures near absolute zero, the internal atomic motion noises found in ordinary vacuum tubes and transistors are almost silenced, making possible amplification of extremely low-level signals.

This column's report of October 20 on Britain's progress in the development of infrared devices for detection of missile launchings up to 1000 miles away failed to excite U.S. scientists in the IR field. One Westinghouse scientist said: "We suggested an IR detection system more than two years ago. The system, working from a satellite, would be capable of detecting an ICBM in its early climb, and telemeter the information back to a ground station. However, for lack of support, the project was shelved until work was recently resumed."

Westinghouse has been in the IR field since 1942 when the company built an IR communication system for the Navy. One of the current projects involves the development of an IR imaging tube known as the Thermicon. The tube works much like a TV scanning tube, but is sensitive to IR radiation rather than visual images.

The Air Force recently asked industry for information on nuclear batteries for power supply in space vehicles. One answer appears particularly promising. The company said it could produce an isotope-bank type battery weighing 100 lbs., and yielding 300 watts for 2.5 years; current efficiency about 8% with an expected increase to 15%, maybe 25%, before long. There was, however, one catch. The high price of isotopes would bring the total cost of one battery up to $10 million. The Air Force is still looking.

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- Nuclear Ramjet

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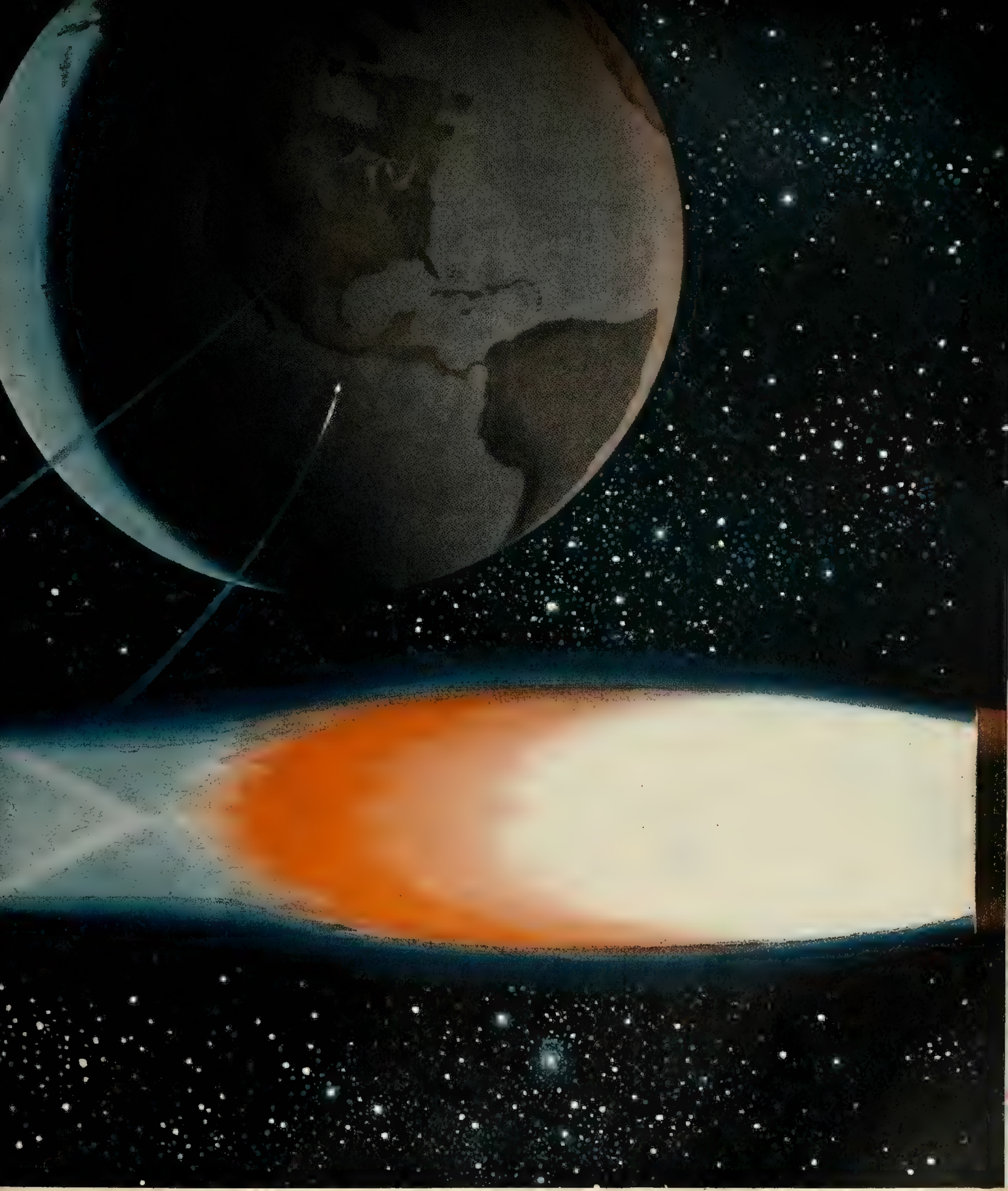
- Evaluation—Energy, Compatibility and Logistics

CONTROLS & ACCESSORIES

- Hot Gas Servo Systems
- Accessory power for Space application
- Variable geometry Inlet Controls

In addition, current application projects include supersonic ramjet power for Bomarc, Super Bomarc, X-7 (test vehicle), Q-5, and Kingfisher.



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New Army Missiles Revealed

by William O. Miller

The Army is moving ahead rapidly to provide frontline troops with a complete spectrum of missiles to provide the mobility, speed and firepower required in the space age.

These missiles range from a surface-to-air bazooka to the 500-700-mile range *Pershing*. While progress in several areas is still at the feasibility study level, the Army has high hopes of early equipment availability to match its established pentomic organization. To the missile industry it will mean a reported expenditure of $5-billion annually for perhaps three years.

Outstanding systems at the divisional and below levels are *Missile Able*, *Mauler* and *Redeye*. *Redeye*, in the feasibility study stage, is a surface-to-air bazooka. Man-portable, *Redeye* will employ infrared guidance to home on low-flying aircraft and helicopters.

Missile Able is a field artillery missile to provide direct support to the battle group. Prime requisites for this surface-to-surface missile are that it be light-weight, with a high degree of accuracy and mobility.

Feasibility studies for *Missile Able* are being carried out by six companies who have been given study contracts of about $60 thousand each. They are General Electric, Minneapolis-Honeywell, Armour, Cornell, Martin and Douglas. Chance-Vought has been carrying out an unfunded study with $6-million in its own funds for another version, reportedly named *Rattler* or Project Firepower, which it expects to test in mid-January (m/r, Nov. 3, p. 7) *Missile Able* will have about a 70-mile range.

The Army expects to receive the reports from contractors by early 1959. Progress reports thus far have failed to indicate whether *Missile Able* will employ inertial guidance or be a free rocket. Whoever wins the competition can expect orders in large numbers.

Mauler's infrared system will give troops surface-to-air offense with six missiles per unit.

Successor to the now-defunct *Dart* will not be the French *SS10* or *SS11* as commonly believed, but will probably wind up in a competition between the German-developed two-stage *Kobra* and the *Vickers 891* now under evaluation by a major U.S. defense contractor.

Backing up *Kobra* will be some version of the atomic bazooka popularly known as the "Gavin Grapefruit" or the "Trudeau Turnip."

Next in line is the mobile *Lacrosse* which will be available at the division or corps level. In this case, a corps will mean three divisions. These are the pentomic divisions which are being organized to be self-sustaining on a wide front.

Along with *Lacrosse* will be the free-flight *Little John* utilized by STRAC (Strategic Army Corps) and by the Army's air mobile divisions.

Honest John would be available to front-line troops at the division level.

Thus, the Army missile line-up is: *Redeye, Cobra, Missile Able, Little John, Honest John, Lacrosse, Corporal, Sergeant, Redstone* and *Pershing*.

In *Pershing*, the Army expects to eliminate many shortcomings of its forerunners by an advanced modular concept, solid propellant, increased mobility and improved field handling and maintenance.

While nuclear warheads are being considered for some of these weapons, Army planners say that a "tailored payload," both as to size and nature, is a major consideration. While the "big bang" in the smaller package may be desirable from many viewpoints, radiation, blast effect, and fallout must be carefully weighed when nuclear weapons are used at short ranges.

Bloodhound Goes Into Operational Service

Great Britain has begun placing its Bristol—Ferranti *Bloodhound* SAM in operational service, installing the first weapons at North Coates in Lincolnshire. The station is a fully operational installation and will include a permanent trials unit concerned with evaluation of the *Bloodhound* system.

The missile, using a semiactive guidance system, is reported to have the longest range in the world for its type. Four solid-propellant rocket motors accelerate the missile to supersonic speed, at which point the ramjet engine takes over. At a certain airspeed, the booster rockets are separated from the missile by air drag and jettisoned. The *Thor*-type ramjet burns kerosene as fuel.

The *Bloodhound* will be used by the RAF and the Royal Swedish Air Force, and is already in mass production by six plants, requiring a labor force larger than that for any comparable project in Western Europe. Working with the Guided Weapons Division of Bristol Aircraft Ltd. on the *Bloodhound* are Bristol Aero-Engines Ltd., Ferranti Ltd., The British Thompson-Houston Co. Ltd., E.M.I. Electronics Ltd., Decca Radar Ltd., and M. L. Aviation Ltd.

In an effort to provide the best possible development potential, Bristol and its team members designed the missile with a monoplane moving wing missile frame and a ramjet powerplant. The missile frame design incorporates a moving wing configuration, enabling it to navigate through a twist and steer maneuver and thus affording high performance at high altitudes. The lift is obtained rapidly and directly from the wing surfaces, with a minimum of change in missile body incidence.

The *Bloodhound* is a complete weapon system, incorporating target-illuminating radar, control posts, and launchers. All integral components are designed for minimum maintenance and long periods of service.

As a result of its *Bloodhound* program, Bristol has recently opened a high-altitude test facility to allow free jet testing of ramjets at simulated altitudes up to 100,000 feet.

Soviet Moon Rocket Has Half-Ton Payload

A payload about the size of *Sputnik II* will be carried in a Soviet moon rocket to be launched "in the near future," according to Soviet sources. Work is being carried on "energetically" on the project, which has two payloads under consideration. One payload would impact. The other would orbit the moon and return to earth.

According to Dr. Vitaliy Bronshten, a Soviet scientist, the payload will be equipped with instruments for determining the moon's mass and conductivity of heat and electricity; with apparatus for investigating the moon's surface and discovering possible landing places for manned space vehicles; with equipment for investigating the moon's magnetic field; and with television apparatus for viewing the dark side of the moon.

Marquardt Plans To Buy Cooper Development Corp.

Marquardt Aircraft Co. has completed negotiations to acquire the Cooper Development Corp. in exchange for 60,000 shares of Marquardt stock and, effective November 20, will operate it as a wholly-owned subsidiary.

President Roy Marquardt said the acquisition is in line with Marquardt's policy of giving continued consideration to a program of diversifications in the field of advanced research and developments relating to flight in the

NEWS FROM FLEXONICS

DUCTING AND COMPONENTS ENGINEERING BRIEFS

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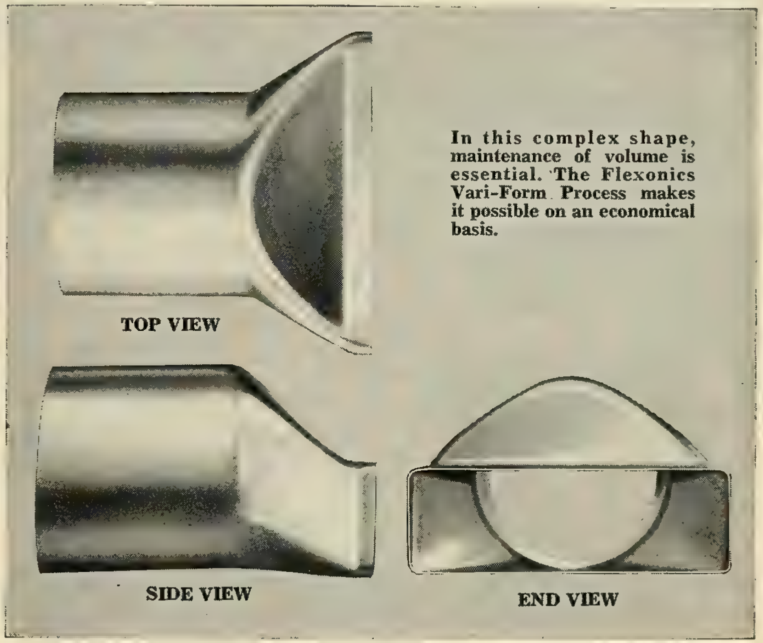

In this complex shape, maintenance of volume is essential. The Flexonics Vari-Form Process makes it possible on an economical basis.

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By specifying Flexon Vari-Form Ducting Components, the designer frees himself from the severe limitations of conventionally formed components. He is not troubled by limitations in configuration. He is assured of maintaining volume when it is required. He is able to hold weight to a minimum. He need not sacrifice strength for other considerations.

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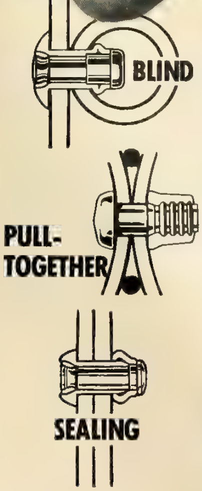
atmosphere and in space. This is Marquardt's second acquisition in the last few years. Earlier it took over the Associated Missile Products Co. from American Machine & Foundry Co. and is now operating it as its Pomona division. The work being done by Cooper Development in high altitude exploration with sounding rockets and rocket components appears to have excellent growth potential, Marquardt said in a recent statement.

Cooper Development has plants at Monrovia, Baldwin Park and Rialto, Calif. It had sales of $2.4 million in the fiscal year ended February 28 last, and anticipates $3.5 million for the current fiscal year. Clifford D. Cooper, president of the corporation, will continue in that capacity as principal executive officer of the Marquardt subsidiary. He also will become a vice president of Marquardt.

Since its inception in 1951, Cooper Development has been associated with research projects to measure atmospheric and meteorological conditions at extremely high altitudes. Among these are the rocket airframe and rocket motor case for the third stage of the Vanguard, the high speed stages of the Explorer, and the LOKI-Rockoon, first cosmic ray rocket fired to more than 400,000 feet altitude.



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White Lance

Liquid Packaged Engine, Nuclear Head

The Air Force has an air-to-surface missile called the *White Lance* (m/r Oct. 6, p. 21), and while the early version is still the Navy's *Bullpup*, an advanced model will incorporate radically-new features.

The advanced *White Lance* reportedly will still resemble *Bullpup* in configuration. Guidance, engine and warhead will be different. *White Lance* will be manufactured by the Martin Company's Orlando Division. Air Force has awarded Martin a development contract with emphasis on guidance.

Several of its brand-new features should be TV guidance, a storable liquid-propellant engine, and a nuclear warhead. *White Lance* will be employed by the Tactical Air Command first, but many NATO-member nations are bargaining for the missile, which conceivably could be manufactured abroad under a licensing agreement.

Air Force has been in the *Bullpup* program for several years, but has not gone along with Navy thinking. Air Force, for example, wants the missile to be stored in aircraft wings, while Navy with its folding wing carrier aircraft, does not have this requirement.

Bullpup's command guidance radio link also has not been acceptable to the Air Force, which authorized Bell Aircraft to come up with a different type. Bell's proposal, however, did not meet with Air Force approval, and the service accepted the Martin developed CORAL (Correlated Radio Link).

But Air Force is still looking in the guidance direction for *White Lance,* and this time the area is TV. The Allegany Ballistics Laboratory solid-grain motor may possibly be set aside by Air Force in favor of a storable-liquid-propellant engine. And most important, *White Lance* probably will have a nuclear warhead instead of *Bullpup's* present 250-pound bomb.

The TV guidance, an offshoot of work started during World War II and culminating with the *Tarzon* missile, is a comparatively recent development. The new system reportedly has overcome earlier complaints about instability and other TV troubles.

The guidance undoubtedly will extend the present visual range of *Bullpup* or *White Lance* to something around horizon limits. A stabilized scanner-transmitter will be mounted in the nose of the missile and a receiver will be pilot-monitored in the cockpit of the airplane. But even with TV guidance, the missile still will not have

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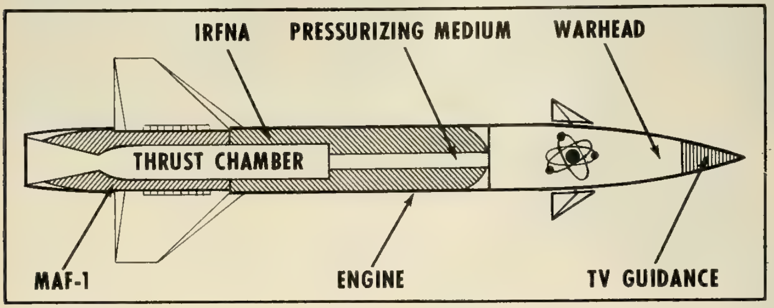

all-weather capability.

The liquid-propellant engine probably will be supplied by Reaction Motors Division of Thiokol Chemical. The engine, model LR 44-RM-2 (dubbed *Guardian* by Reaction in its *Sparrow* III application), will be supplied in fully-loaded condition, being fueled in the factory before shipment for assembly in the missile.

It uses inhibited red fuming nitric acid (IRFNA), and a Reaction Motors proprietary mixed amine fuel (MAF-1) for propellants. Operation of the engine is started by igniting a solid propellant gas generator which pressurizes the fuel tankage, and opens ports to the combustion chamber by forcing a shear slide forward. This simultaneous action allows the propellant to flow into the combustion chamber, where it is mixed by the solid propellant gases to insure proper burning.

To date, two models of the engine have been fired and another is slated to undergo test soon. All of this testing has been on the ground with flight tests still some time away.

Major advantage claimed by Reaction is that the packaged-liquid engine can be stored on the shelf for literally "years." Reaction sees many future uses for this type of engine in medium-sized missiles of the future, and even the possibility that large ballistic missiles in hard bases would use the new unit. *Bullpup's* present solid reportedly only has a useful limit—without replacement—of about six months.

Unfortunately, with all its sophistication, Reaction's new engine cannot properly be called a "breakthrough." The Germans, many years ago, had a missile called the *Taifun* (Typhoon), which had a packaged liquid. The missile was boosted to flight velocity by a solid booster and the accelerations imposed during the solid phase of its flight opened valves which started fuel flow and engine combustion.

The packaged-liquid concept puts new life into the liquid-solid battle which many have already conceded to the solids. Storable liquid engines, with their reasonable accelerations, might very well be the answer to shock and acceleration problems which have become a plague to designers.

Cost of *White Lance*? Martin officials or the Air Force can not say, but one *Bullpup* costs about $25,000 a copy in the prototype stage (not counting R&D money) and the missile is running about $6,000 per bird in production. "Sophisticated" *White Lance* undoubtedly will run higher.

French to Test Two More Research Missiles

First tests of the new French research missiles, *Veronique* and *Monique*, are expected to be held early next spring at the North African proving ground near Colomb Dechar.

The *Veronique*, according to Pierre Blassel of the French Directorate of Communications, is 24 feet long, 2 feet in diameter and carries a payload of 140 pounds to altitudes of 250 miles. The *Monique*, a smaller vehicle, carries a 30-pound payload. Both rockets were developed by the French Army, but are now being used by a civilian agency.

Blassel acted as spokesman for a visiting delegation of French military personnel making a tour of U.S. Air Force Bases in this country. The only private corporation visited was Cubic Corp., a San Diego firm engaged in electronics.

The North African missile test center has been in operation for about 10 years, with primary interest being centered around surface-to-surface and surface-to-air missiles. Blassel mentioned the *SS-10* and a missile comparable to the *Nike-Ajax* as examples of recent test activities.

British Say *Firestreak* Superior to *Sidewinder*

British and Australian military spokesmen have indicated misgivings about the performance of the *Sidewinder* AAM.

British authorities have commented that the *Firestreak* is superior and claimed it is a "much more advanced and powerful weapon." The Australians, meanwhile, criticized what they termed the narrow sector in which the *Sidewinder's* guidance operates.

The missile could conceivably head into the sun, they said, and claimed that jet aircraft could easily evade it. "All an enemy pilot has to do is fire a flare and the *Sidewinder* takes off after the flare," they said.

Sidewinder, however, has been an effective weapon in the current Quemoy crisis.

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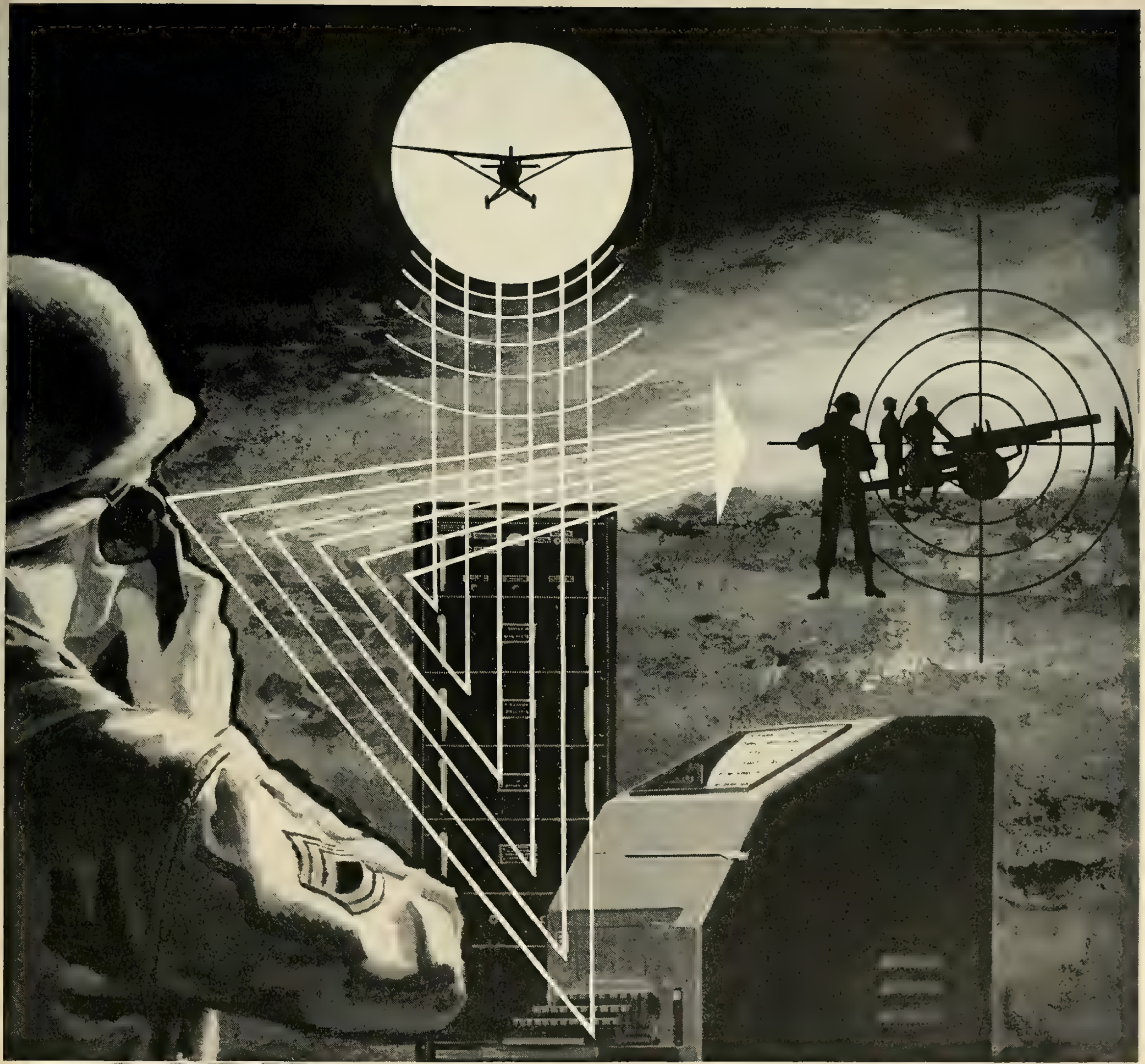

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. . . the missile industry

(Continued from page 14)

$3.7 billion was available for more procurement.

All agree that a sum running over a third of all missile expenditures—about $2 billion—is being spent at the same time for research and development work—some of it going to the same prime and subcontractors, some to engineering firms, universities and individual consultants.

• **R&D a special subject**—The heavy emphasis on research and development activities also brings a special flavor into any attempt to estimate the size of the missile field—partially because it has brought a new factor into the general business picture.

In the past four months, for example, m/r has reported more than 800 contract awards varying in size from a few thousand dollars to several million. A good one third of these—for a substantial aggregate sum—are for research and development.

And the new factor is that most major U.S. universities have emerged as major contractors in this field. The use of university laboratory and other facilities to aid industry is not, of course, a new thing to American industry. Laboratories such as Lehigh University's Fritz Engineering Laboratory at Bethlehem, Pa., have long been employed by manufacturing companies to investigate phases of their work—such as the strength or heat-resistance of materials.

But roughly 92 technical universities have emerged as contractors in their own right in missile work, bidding for work against private research organizations. How to classify them as a part of an industrial field is a baffling problem.

Of course, the whole emphasis on R&D work for missiles is something new in itself. Many established industries maintain research sections or agencies—but no industry has ever been built on the fact that more than a third of its total strength is allocated initially and directly to research as a separate activity.

• **More concerned**—Beyond the industrial and consulting groups that can be directly identified with missiles are the several thousand organizations that figure in the field in some way.

For example, the Army's Corps of Engineers recently let sizable construction contracts for missile bases, to firms whose business is construction—not missiles. Other buinessmen are supplying fuels, services (including repairs), housing both for personnel and for the "birds" themselves. Feeding, medical care, transportation both local and national are a part of the picture too. For instance, trucking firms whose principal business has been the moving of household furniture have moved swiftly into the business of transporting missiles. Railroads have also eyed this phase of missile work—the New York Central, for intance, recently demonstrated a specially-built flatcar for transporting the big weapons.

Camera and film companies, manufacturers of nuts and bolts, machine tools, fasteners, wiring and plastics, suppliers of basic raw materials such as steel and other metals and ceramics, are also concerned.

By way of illustration, the Connecticut Development Commission recently published a survey of state industry, which showed that 224 firms in the state were (in mid-year) supplying parts and services for missiles.

Significantly, the survey found that another 272 firms considered they could also contribute to missiles—and were seeking means of getting into the business.

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STRAIGHT TALK TO ENGINEERS

from Donald W. Douglas, Jr.

President, Douglas Aircraft Company

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Bureau of Standards: Calibration Is Its Task

Recently Opened Colorado Facility Establishes Electronics Standards Widely Used by Missile Industry and Government

by Raymond M. Nolan

In the October 27 issue of m/r, a description of the four primary standards of measurement was given. These were: time, the meter, the kilogram and the degree. While all of these are basic to measurement of physical phenomena, the precise measurement of units peculiar to the electronics field are more in the forefront today. Recognizing this, the National Bureau of Standards recently established an Electronics Calibration Center at Boulder, Colo. Housed in a new wing of the Radio Standards Laboratory, the Center provides government, industry and the military services with access to the nation's primary electronic standards.

Here are calibrated the master working standards which in turn are used to adjust the instruments on production lines and in research laboratories—activities vital to the progress of future electronics programs in communications and space technology.

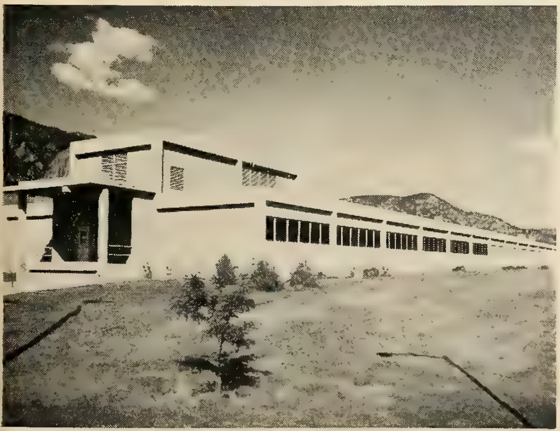
The primary mission of the NBS Electronic Calibration Center is to calibrate interlaboratory standards for such quantities as voltage, power, and impedance in terms of the national standards maintained by NBS. These interlaboratory standards, in turn, are used to assure the accuracy of reference and working standards in laboratories, on the production line, and in overhaul stations throughout the nation.

The fundamental system of electrical measurement now employed in the United States uses absolute units, this is, units derived from the fundamental units of length, mass and time—the meter, kilogram and second. Basic to the absolute system of electrical units are the absolute ohm and the absolute ampere. The absolute ohm is derived from the absolute henry, based on an inductor of accurately known dimensions. The absolute ampere is established in terms of the magnetic force of an accurately dimensioned current-carrying coil measured with a current balance. These basic standards are maintained in the Bureau's laboratories in Washington. Other units, such as the watt and the kilowatt hour, are obtained by combining these units and by extending the scale of measurement. The units are then transferred to higher frequencies by appropriate techniques.

The new center is offering services in three broad frequency ranges: low frequency (through 30 KC), high frequency (30 KC through 300 MC), and microwave (above 300 MC). The center recognizes that these will be future needs beyond what they are doing now, but plans to measure and standardize in the center all electronic quantities for which these is a substantial calibration need. Calibrations required only infrequently will still be obtained elsewhere within NBS.

In the low frequency region, the center provides calibrations for such electrical standards as resistors, bridges, potentiometers, inductors, capacitors, standard cells, electrical instruments, ratio devices and instrument transformers. Even though these devices are available at the center, the standards previously available at NBS in Washington will continue to be in force, in some cases with wider ranges than the new center can provide. In either case, the standards available will be in terms of the national primary standards.

• **Resistance standards**—NBS in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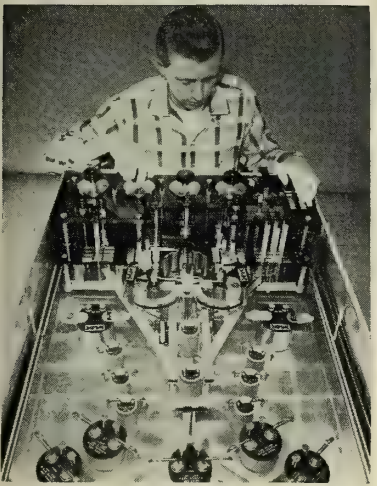


DECADE CAPACITOR is calibrated at audio frequencies using a capacitor bridge.

Washington maintains the unit of resistance by means of 10 extremely accurate, sealed, double-wall one-ohm standard resistors. This group also forms the basis of measurements made in the center. A Wenner bridge, including a thermostatically regulated oil bath for maintaining a constant known temperature, is used for calibrating standard resistors. A direct-reading ratio set is used to compare resistors with known standards by either a Kelvin double bridge or a Wheatstone bridge. Resistance comparisons, using a Wenner bridge, can be made to one part in 10 million under optimum conditions.

The components of bridges and resistance boxes are calibrated with known standard resistors by use of a direct-reading ratio set. Potentiometers are calibrated with a universal ratio set.

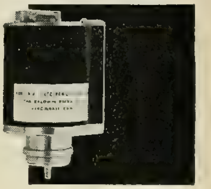
- **Inductance Standards**—Stable standards of self-inductance are used as components of a-c bridges and other circuits used in impedance measurements. An equal substitution method using a Maxwell-Wien bridge is now employed in the center. Three groups of calibrated inductors, capable of intercompared frequently to detect relative drifts of changes, serve as standards. One of these groups is calibrated periodically against the national standards of capacitance and resistance. Future plans are to construct a bridge which will measure even wider ranges of inductances and to check the stability of standards.

- **Capacitance Standards**—Equipment used in the center for calibrating capacitors consists of a capacitance

SUBMINIATURE 13-DIGIT ENCODER *for airborne or other limited space applications. Detailed specifications in Bulletin 0858.* **SIZE:** *$2\frac{5}{16}$" dia. x $3\frac{3}{4}$" long; $\frac{1}{4}$" dia. shaft, $\frac{7}{8}$" long.* **WEIGHT:** *$1\frac{1}{4}$ lbs.* **OVERALL ACCURACY:** *± $1\frac{1}{4}$ quanta in 8192.* **READOUT RATE:** *Model A, nominally 10KC (50 microsecond pulse), max. of 100KC (5 microsecond pulse). Model B, max. of 200KC for element, 10KC for sequence.* **MAXIMUM ANGULAR SPEED OF ROTATION AT FULL ACCURACY:** *2 rpm (6 rpm at 12-digit accuracy). 10 rpm with temperature control.*

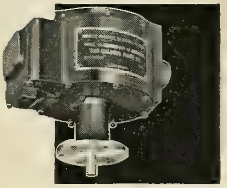
Model A2.6SS13
(Parallel readout)
Model B2.6SS13
(Sequential readout)

4" DIA. 13-DIGIT ENCODER *for general purpose applications. Detailed specifications in Bulletin 0958.* **SIZE:** *4" OD with protrusions on one side x 7" long; $\frac{1}{4}$" dia. shaft, 0.67" long.* **WEIGHT:** *$9\frac{1}{4}$ lbs.* **OVERALL ACCURACY:** *± 1 quanta in 8192.* **READOUT RATE:** *100 cps, max.* **MAXIMUM ANGULAR SPEED OF ROTATION AT FULL ACCURACY:** *720 rpm; maximum rotation rate, 600 rpm.*



Model A4DP13

6" DIA. 13-DIGIT ENCODER *for general purpose applications. Specifications in Bulletin 1058.* **SIZE:** *$6\frac{3}{16}$" dia. with protrusions x $7\frac{3}{4}$" long; $\frac{1}{2}$" dia. shaft, 1" long.* **WEIGHT:** *14 lbs.* **OVERALL ACCURACY:** *± 1 quanta in 8192.* **READOUT RATE:** *100 cps, max.* **MAXIMUM ANGULAR SPEED OF ROTATION AT FULL ACCURACY:** *720 rpm (10 microsecond pulse).*



Model A6DP13

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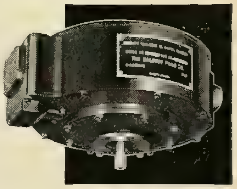
Baldwin®

precision shaft angle analog-to-digital encoders in 5 standard models:

13, 16 and 18 digit / photoelectric readout / reflected binary code.*

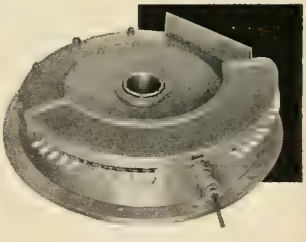
9" DIA. 16-DIGIT ENCODER *precision unit for radar applications. Detailed specifications in Bulletin 1158.* **SIZE:** *$9\frac{1}{16}$" dia. with protrusions x $4\frac{3}{8}$" high; $\frac{1}{2}$" dia. shaft, $1\frac{1}{4}$" long.* **WEIGHT:** *$17\frac{1}{2}$ lbs.* **OVERALL ACCURACY:** *± 1 quanta in 65,536.* **READOUT RATE:** *100 cps, max.* **MAXIMUM ANGULAR SPEED OF ROTATION AT FULL ACCURACY:** *90 rpm (10 microsecond pulse).*



Model A9SP16

HIGH PRECISION 18-DIGIT ENCODER *for radar or theodolite applications. Detailed specifications in Bulletin 1258.* **SIZE:** *21" max. dia. x $8\frac{1}{16}$" high.* **WEIGHT:** *169 lbs.* **OVERALL ACCURACY:** *± 1 quanta in 262,144.* **READOUT RATE:** *100 cps, max.* **MAXIMUM ANGULAR SPEED OF ROTATION AT FULL ACCURACY:** *25 rpm (10 microsecond pulse).*

*Encoders with decimal, trigonometric functions and other nonlinear codes are also available. All disks are made on a special divided circle machine designed and built by Baldwin. *Write for descriptive bulletins.*



Model A21SP18

Industrial Products Division
THE BALDWIN PIANO COMPANY
1802 Gilbert Avenue, Cincinnati 2, Ohio

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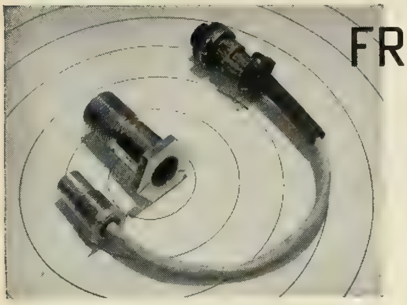
do you have these missile power problems?

FRACTURING?

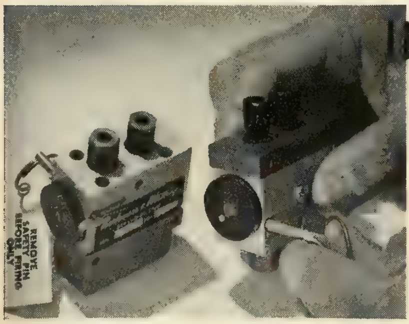


Frangible bolts from the Beckman & Whitley line combine the optimum in dependability and convenience for separating structures by electrical signal. Made to specifications, these bolts are internally threaded to receive the pre-wired charge which then attaches by standard connector to the missile circuitry provided. We'd like to help with *your* needs.

DISCONNECTING?

Double certainty of positive electrical disconnecting is provided by the selectively fired, two-charge design of this example from the line of Beckman & Whitley electrical disconnects. Shown assembled at right, this device can be provided with alternative primers as shown in the center. Shear pins hold the unaltered electrical connector assembly rigidly together until either or both primers are fired. Ideal for umbilical connections or other applications where guillotine choppers are not applicable. Perhaps these would help on *your* project.

INITIATION?



Same basic mechanism serves, right, as a detonator-safe primacord initiator, having a lanyard-operated safety pin; or, by the substitution of an explosive charge, bottom left, unit becomes a destructor. Two separate channels for top reliability, mechanism so designed that reinsertion of safety pin reverses unit from "arm" to "safe" position. If these sound too simple, we can show you some *complicated* ones.

Pre-packaged explosive power units provide higher reliability and greater power for a given weight and volume of space than any other actuation method. Some of the many other applications to valving, ejecting, fracturing, etc. may be interesting to you. Just ask us.

Beckman & Whitley INC., San Carlos 16 California

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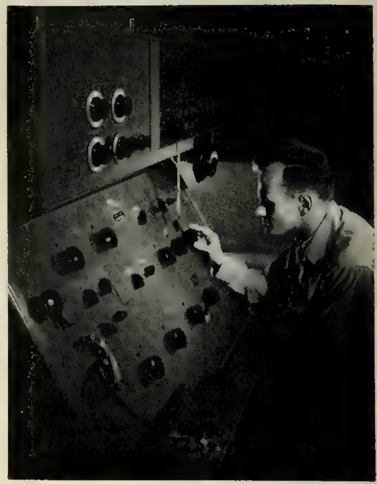


WENNER BRIDGE is used for calibrating these accurate, sealed double-wall 1-ohm standard resistors.

bridge having internal capacitance standards which are, in turn, calibrated by step-up procedures using standard capacitors. Three groups of standard capacitors, with one group calibrated in terms of the national standard of capacitance, are used for intercomparison to detect relative drifts or changes.

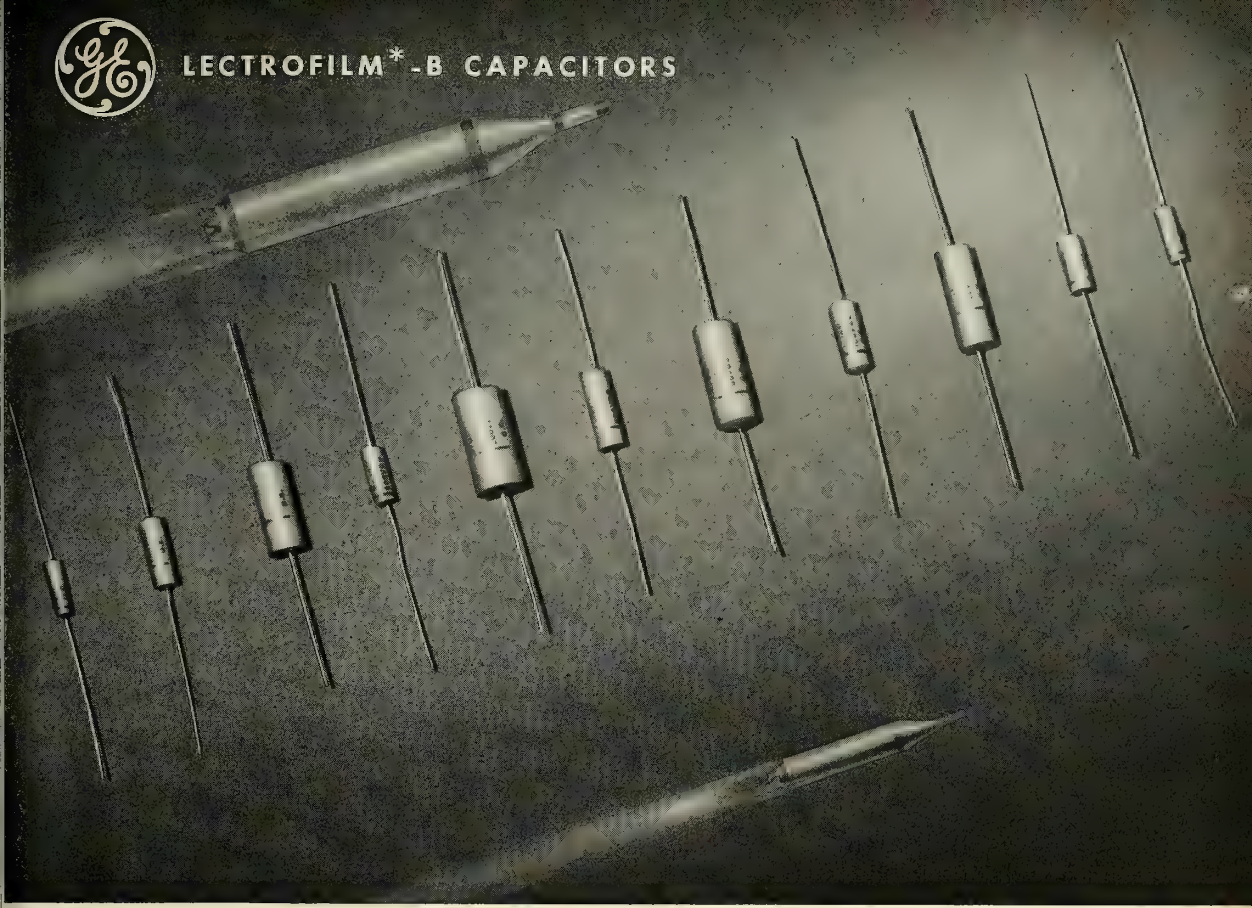
Fixed capacitors, with air dielectric for low values of capacitance and micro dielectric for higher values, are used as components of a-c bridges as standards for the external calibration of bridges and for the calibration of other standards by substitution.

- **Standard Cells**—The center calibrated both types of Weston cadmium standard cells: saturated cells, used principally for reference standards of electromotive force, and unsaturated cells, used mainly as working standards of electromotive force.

The cells are compared directly with saturated standard cells with a microvolt potentiometer and the standard cells are compared periodically with the group of saturated cells which the Bureau uses to maintain the unit of electromotive force.

The emf of standard saturated cells is presently measured to a precision of about two microvolts with an accuracy of 0.001 per cent. However, a temperature-controlled oil bath, scheduled for completion at the end of the year is expected to give even greater accuracy.

Unsaturated standard cells have rather low temperature coefficients of about five microvolts/degrees O. Con-



General Electric Announces for Missile Use . . .

New Lectrofilm*-B Capacitors for 44,000 Hours of Reliable Life

New G-E Lectrofilm-B capacitors offer you maximum reliability at lowest possible cost . . . results of over 3,000,000 unit-hours of life test data (per G-E Spec. MTC-3) indicate a probability of survival in excess of 0.99 for 44,000 hour life under rated voltage at 85C. Under rated voltage at 125C, the indicated probability of survival is in excess of 0.98 for 44,000 hour life.

LOW FAILURE RATE AND LONG LIFE of these inexpensive G-E capacitors result from using only the highest quality materials and the closest of process controls . . . units are tightly wound with high-purity aluminum foil and capacitor-grade Mylar† film dielectric. No solder is used, and introduction of contaminants through impregnation is eliminated.

SMALL, LIGHTWEIGHT ENCLOSURE consists of tape wrapped around the compact roll and sealed with epoxy resin, forming a rugged case which resists humidity, vibration and shock.

TO MEET YOUR APPLICATION REQUIREMENTS, 14 case sizes are available in five ratings—100-, 200-, 300-, 400-, and 600-volts. Capacitance range within each rating is: 0.015 to 0.68 uf in 100 volts; 0.010 to 0.47 uf in 200 volts; 0.0047 to 0.22 uf in 300 volts; 0.0033 to 0.15 uf in 400 volts; and 0.0010 to 0.10 uf in 600 volts.

GET A QUOTATION TODAY ON NEW LECTROFILM-B CAPACITORS by contacting your General Electric representative. Ask for your copy of life-test data and G-E Specification MTC-3. Or, write to Section 447–4, General Electric Co., Schenectady, N. Y.

**Trade-mark of General Electric Co.* *†Reg. trade-mark of DuPont Co.*

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sequently, temperature control is not nearly as important as for saturated cells. Results of calibration are usually given to 10 microvolts and the cells are certified to 0.01 per cent.

• **Electrical Instruments**—Indicating instruments, whether they are used for direct reading or for calibrating other instruments, are essential to the measurement of electrical quantities. The center can calibrate instruments in the 0.5 percent accuracy calls or better.

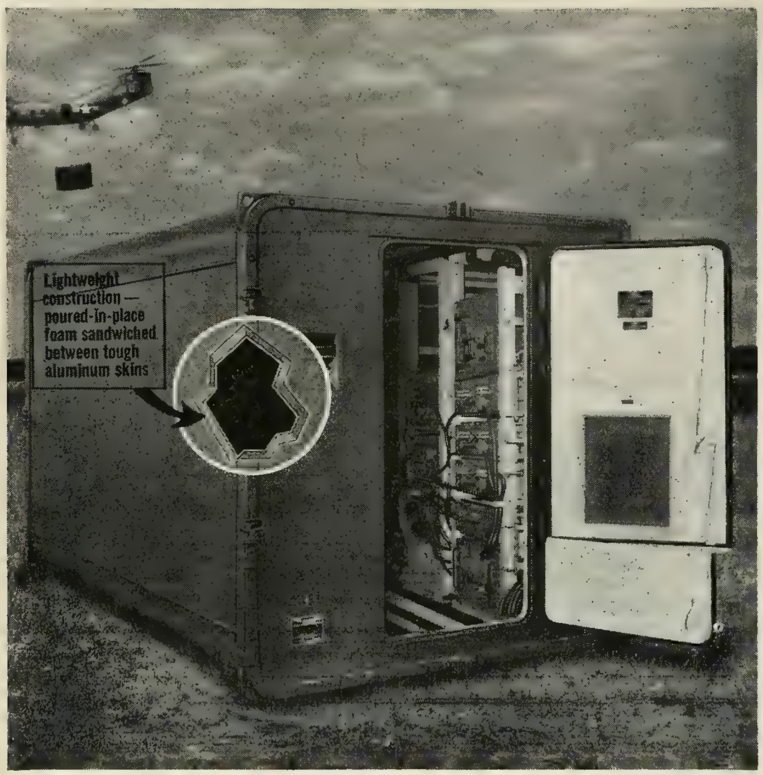
The basic standards for d-c calibration of electrical instruments are standard cells and resistors, and the standard measuring apparatus is a potentiometer. Corrections for the standards are known and applied to obtain measurements of high accuracy.

• **Transformers**—The center calibrates (at 60 cps) transformers having 5-ampere secondary windings and primary current ranges of 0.1 to 4000 amperes, and voltage transformers with 110 to 120-volt secondaries and primary-to-secondary voltage ratios of one to 120. Plans are in the works to do this same work at 400 cps.

• **High Frequency**—In the high-frequency region (30 kc to 300 Mc) the Electronic Calibration Center is being equipped initially to calibrate standards of voltage (unbalanced), power, impedance, attenuation, and field strength. These standards are limited at present to those designed for continuous-wave measurements.

For each of the quantities to be measured, stable cw sources of high-frequency power and stable detectors or indicators are required. To achieve the desired frequency stability of the calibration system, crystal-controlled power sources and receivers are used wherever possible. In addition to good frequency stability and waveform, the sources must have very nearly constant power output. Power-stabilization circuitry has been developed that will hold constant the power output to better than 0.1% over long periods of time. Crystal-controlled superheterodyne receivers serve as monitors of detectors to give comparable frequency stability and to provide the necessary sensitivity. Most of the high-frequency instrumentation has been assembled in console form.

For most quantities, calibration services are planned primarily for the nine fixed frequencies of 30, 100, and 300 kc, and 1, 3, 10, 30, 100, and 300 Mc. Other frequencies will be available for some quantities. In addi-


Lightweight construction — poured-in-place foam sandwiched between tough aluminum skins

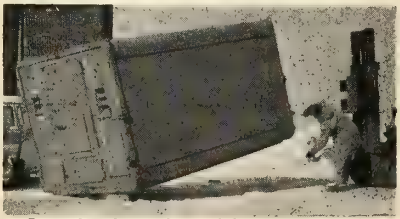
POURED-IN-PLACE FOAM and THE CRAIG HELICOP-HUT*

The term Helicop-Hut* is a copyrighted trademark name that stands for the original of the design of a Craig shelter using a combination of poured-in-place foaming processes, high tensile aluminum sheet and extrusions, and Epoxy Resins to achieve the optimum of insulation "K" factor, ruggedness and lightness in weight. This type of foam construction is non-hygroscopic, non-nutrient to fungus, and capable of withstanding severe thermal shock. A two-inch thick aluminum-faced panel has an insulation "K" factor of 0.115.

Developed and perfected by Craig engineers over the past four years, these foaming processes and fabrication techniques, together with the details of structural design, are now being incorporated into an increasing number of shelters built to military specifications, including S-97, S-98, S-118, S-138, S-141, S-144, S-152 and S-155.

You get this kind of built-in reliability only from Craig. And you find it in *all* Craig shelters and vans, from tactical communication and navigation centers to missile firing, sighting, and checkout stations.

Also worth remembering: Craig production schedules are geared for early delivery — prototype or production. *For complete information, write or phone:*



Strength and ruggedness of foamed-in-place plastic and aluminum construction is illustrated by this rotational end drop test of Craig Model 129 Helicop-Hut with 6,000 pound payload.*

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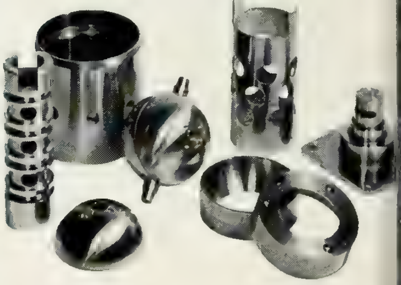

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tion to the fixed frequency apparatus, continuous frequency coverage is provided wherever feasible. However, this equipment will be less stable and less accurate.

- **High-Frequency Voltage**—The instrumentation for high-frequency voltage calibration consists of stable transfer standards which operate over the desired range of voltages and frequencies. The range of voltage to be covered by presently planned equipment is from 1 microvolt to several hundred volts, and the frequency range is from 30 kc to 700 Mc (later to 1000 Mc) at 13 fixed frequencies. The top limit of the voltage range will be lower at the higher frequencies.

Voltage levels of 0.2 V and higher are covered by the voltmeter calibration consoles. The transfer standards used in these consoles are attenuator-thermoelement (AT) voltmeters. The attenuators are of the dissipative, capacitive, or waveguide-below-cutoff type. Dissipative attenuators are used at voltage levels up to 20 V. Above this level the power requirement are so great that this type of attenuator is not practical. For higher voltage levels, capacitive attenuators are used at the lower frequencies and waveguide-below-cutoff attenuators at the higher frequencies. The AT volemeters have been provided with a mount which permit a very short lead length between the standard and the meter under calibration. This mount is so constructed that any type of voltmeter can be connected by means of a simple adapter.

Employed in the voltmeter calibration consoles are fully shielded, stable crystal-controlled sources. The consoles contain protective circuits that prevent overloading and consequent change in calibration of the standard volt-meters. These meters are calibrated in terms of the national standard of high-frequency voltage and provide a calibration accuracy of approximately 3 percent.

Voltages from one microvolt to 0.1 V will be covered by the microvolt calibration console. The transfer standard used in this console is the rf micropotentiometer, consisting of a coaxial rf resistor and a thermoelement. The thermoelement indicates the current through the resistor, and therefore the voltage across it. The resistors vary from one milliohm to one ohm to cover the voltage range. These resistors and thermoelements are so constructed that their response is essentially uniform over the required frequency range. Power from the rf sources in the voltmeter calibration console will be used also for the microvolt calibration console. A series of very sensitive fixed frequency receivers, adjusted to have an input impedance of 50 ohms, transfers the reference voltage level from the micropotentiometer to an instrument undergoing calibration. The exptected accuracy of calibration for the lower frequencies is +5% for the range 1 to 10 microvolt and +3% for the range 10 microvolt to 0.2 V. The accuracy will decrease as the frequency increases.

- **High-Frequency Power**—Three instruments provide high-frequency power calibration over a wide range of power levels: A thermistor bridge; a dry, static calorimeter; and a liquid-flow calorimeter. These three instruments offer a convenient means of establishing high-frequency power levels and for calibrating feed-through wattmeters.

The thermistor bridge is an equal-arm Wheatstone bridge with a thermistor in one arm. Power levels up to 100 mw can be measured over the frequency range 30 kc to 300 Mc with an accuracy of 0.5 percent. This accuracy limitation is due to substitution error and mount efficiency considerations

QUALIFICATION TEST REPORT BY AEROTEST LABS: VITAL STEP TOWARD RELIABILITY AND ACCEPTANCE

In today's highly technical and competitive aeronautical equipment business, a certified qualification test report from Aerotest Laboratories serves many important purposes. It proves that your product meets all specification requirements. It is evidence that your designers have achieved built-in reliability. And it adds a mighty big gun to your sales ammunition, because all leading contractors and Government agencies recognize Aerotest as a leading independent source for reliable, impartial testing of aircraft, missile and spacecraft equipment. **Aerotest is an approved prime contractor to the U.S. Navy and Air Force. Complete, modern facilities and creative test engineering for all functional and environmental tests on electronic, mechanical, pneumatic, hydraulic and avionic equipment.**

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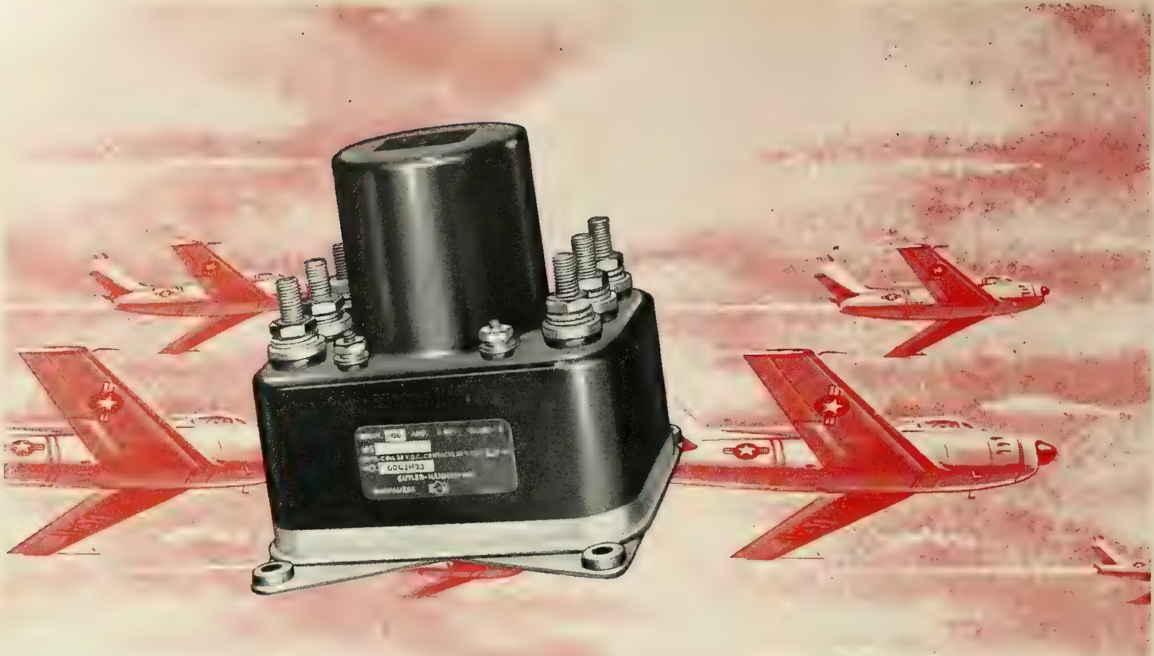


Setting the pace for the Jet Age

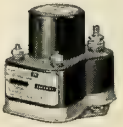
Cutler-Hammer Hermetically Sealed Relays not only were designed to meet the high standards of Mil-R-6106; but also repeated tests prove they exceed many of the requirements with a wide margin of safety. Their performance under the most adverse test conditions has resulted in their adoption as the standard for "special use" by leading aircraft builders. And this *family* of Cutler-Hammer Hermetically Sealed Relays is not a mere dream for tomorrow; it has been in mass production for more than four years!

Cutler-Hammer Hermetically Sealed Relays, designed for either 28 volts D-c or 115/200 volts A-c, are available in a wide range of types and capacities.

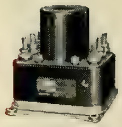
Be sure you have the latest data. Write *now* on your company letterhead for Pub. EE140-W224. Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

Cutler-Hammer Power Relays Finest in Flight

Cutler-Hammer Hermetically Sealed Relays are designed to meet Spec. Mil-R-6106. Operate at 80,000 feet. Class A can operate in ambient temperatures to 71°C; Class B in ambient temperatures to 120°. Class B are available with or without auxiliary contacts.



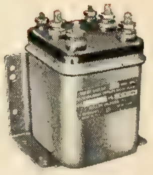
50 amp. single pole, single throw Class A power relay.



100 amp. three pole, single throw Class B power relay.

200 amp. single pole, single throw Class B power relay with N.O. and N.C. auxiliary contacts.

25 amp. three pole, single throw Class B power relay with N.O. and N.C. auxiliary contacts.



50/25 amp. single pole, double throw Class B power relay.

25 amp. three pole, double throw reversing duty Class B power relay.

CUTLER·HAMMER

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rather than to the bridge instrumentation itself. The accuracy is reduced to about 5% as the minimum power level of 0.1 mw is approached.

With calibrated attenuators and directional couplers, the range of the bridge can be extended to 100 watts in the 100 to 3000 Mc region. However, under these conditions the overall accuracy of the apparatus in somewhat reduced.

The dry, static calorimeter consists of a special 50-ohm disk-type load resistor surrounded by a thick aluminum case. The load resistor has a very low temperature coefficient of resistance and provides a VSWR of less than 1.20 for frequencies below 300 Mc. It is heated by applying rf power, and its temperature is indicated by the emf from a 50-junction thermopile. The temperature of the aluminum case is kept constant to 0.002°C by a refrigeration unit and an electronically controlled heater cycling circuit. After equilibrium has been attained, the thermal emf is measured with a precision d-c potentiometer.

The thermal emf is calibrated in terms of applied dc power. Over the frequency range 0 to 300 Mc the overall accuracy is 1% for the power range of 20 mw to 12 w.

Nearing completion is a liquid flow calorimeter that is expected to be accurate to one percent over a range of 10 to 350 w at frequencies from 0 to 1000 Mc. It measures the temperature rise of oil flowing past a load resistor. This temperature rise is monitored with a 10-junction integrating thermopile. A precision d-c potentiometer measures the thermal emf, and a calibrated flow meter measures the oil flow rate. An absolute calibration also can be made by determining the specific heat of the oil and making an independent calibration of the thermopile emf as a function of temperature difference.

• **High-Frequency Impedance**—The standards of high-frequency resistance, inductance, and capacitance consist of stable components housed in shielded mounts. These standards are calibrated in terms of the national standard of high-frequency capacitance using susceptance variation techniques. The mounts have a special coaxial connector which mates with those on the impedance bridges used in the center.

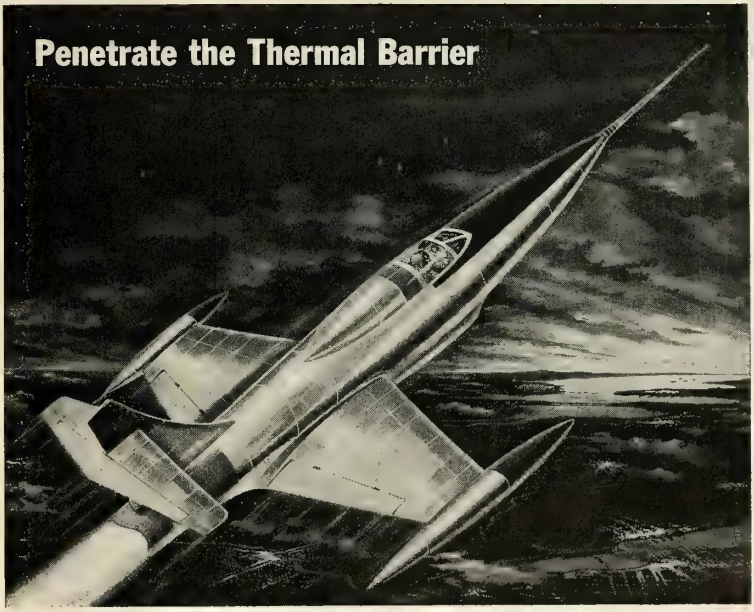
This standardized connector was designed to provide a clearly defined reference plane and to minimize the effects of discontinuities in the connection, thus giving the standard an unusual value. Such a connector reduces the loss of accuracy in transferring the value of the standard to any instrument with which it is to be used.

The values of the present set of standards range from 1 to 100,000 uuf for capacitance, 0.01 to 10,000 uh for inductance, and 1 to 100,000 ohms for resistance, with nominal values of 1, 2, or 5 times appropriate multiples of 10. These comprise a set of about 51 units, plus special mounts for combining units to obtain complex impedances.

The major portion of the impedance calibration services ultimately will be provided through the use of 18 bridges, each contained in a separate console and provided with its own individual exciter and detector. These bridges, currently under construction, will consist of an impedance and an admittance bridge for each of nine fixed frequencies. The design goal is to provide a direct reading accuracy of 0.1 percent.

Four general-coverage bridges have been provided for interim use during the construction of the 18 fixed-frequency bridges and also for calibrations at frequencies other than those covered by the fixed-frequency instruments.

• **High Frequency Attenuation**—To meet present-day accuracy requirements for high-frequency attenuator



MicroMach ***extra-high-tensile stainless steel sheets***

up to **48″ WIDE** ***for aircraft and missile use***

As the speed of today's aircraft rapidly approaches the Thermal Barrier, conventional metals are being left far behind in the race to satisfy the structural requirements of supersonic craft. Needed are metals that can withstand the intense heat caused by air friction at high speeds and still retain their strength. One such metal, MicroMach stainless, has been in use for more than a year.

MicroMach is a special aircraft and missile grade of modified type 301 stainless steel sheet furnished to higher mechanical properties than are available in other commercial high tensile grades in the full hard condition.

These sheets are rolled to extremely close tolerances (as low as plus or minus 3%) with micro-accuracy and precise uniformity of gauge. The surface of Micro-Mach sheet is smooth, clean and dense; qualities so important in minimizing surface friction.

For further information write to Aircraft Steels Dept.

Washington Steel *Corporation*
11-H WOODLAND AVENUE
WASHINGTON, PA.

MicroRold stainless steel is also available in all popular grades and to meet regular government specifications. Sheets up to 36″ wide can be had as thin as .005″, and over 36″ to 48″ wide as thin as .010″ in all commercial finishes and tempers.

Circle No. 46 on Subscriber Service Card.

calibrations, complicated instrumentation designed and adjusted for a single, fixed operating frequency is usually required. The fixed frequencies chosen by the bureau meet the great majority of requirements, as determined by analysis of calibration requests over the past few years.

A recent development program has produced a superior waveguide-below-cutoff attenuator which extends the available calibration accuracy well beyond that of previous standards. Attenuators of this type will be used as attenuation standards in the center. These are being incorporated into special calibration consoles, using a two-channel, null detection, direct substitution measurement system. Pending completion of this instrumentation, a limited calibration service is being maintained using other equipment.

- **High Frequency Field Strength**—The center offers a calibration service forfield strength meters in the frequency range from 30 cps to 300 Mc. The overall linearity of the instrument, the internal attenuator ratios, and the antenna coefficients can be measured, and the instrument can also be calibrated as a two-terminal rf voltmeter. All calibrations are made in terms of sinusoidal voltages and currents. The instrumentation used for this work is continuously tunable over the radio part of the stated above frequency range.

The attenuator ratios and the overall linearity of the field strength meter are measured in terms of precision dissipative coaxial step-type attenuators, calibrated against a standard waveguide-below-cutoff attenuator. Field strength meters using either loop or dipole antennas can be calibrated.

- **Microwave**—Microwave facilities are being provided at the center to measure attenuation, power, frequency, and impedance. The frequency range to be covered extends from 300 to 40,000 Mc for attenuation, power and impedance calibrations, and to 75,000 Mc for frequency calibrations. For components utilizing standard 3/8 in. rigid coaxial terminals with standard Type N connectors, calibrations will be made over the frequency range from 300 to 4,000 Mc. For components utilizing standard rigid rectangular waveguide terminals with standard waveguide connectors or flanges, calibrations will be made over the frequency range 2,600 to 40,000 Mc, and up to 75,000 Mc for frequency calibrations.

- **Microwave Attenuation**—Attenuators are usually calibrated by the I-F substitution method. In this method, power is fed through the microwave attenuator and, after frequency conversion, through a standard 30 Mc attenuator. The standard is a cylindrical section of waveguide operated below cutoff and having attenuation properties that are accurately determined by calculation, precise construction, and evaluation. Microwave attenuators are calibrated in terms of this standard.

Due to limitations in the linearity of the frequency conversion process, attenuation values above about 40 db are measured by the direct substitution method. In this method, microwave attenuators previously calibrated by the I-F substitution method are connected in series with the unknown and are used to determine its attenuation.

- **Microwave Power**—Microwave power calibrations are made by comparing an unknown bolometer with a calibrated standard bolometer. In this method, stabilized continuous-wave power of a single frequency and constant level is fed into transmission-line terminals connected to the standard bolometer or to an unknown bolometer. Both the standard and unknown

(Continued on page 71)

Today artificial satellites orbit in space. Missiles can span continents. Conservative scientists calmly talk of landing on the moon.

Just as they have contributed to other aeronautical sciences, the various divisions of United Aircraft Corporation have made significant contributions to these new fields of missiles and space technology.

Recently the outstanding scientists and engineers who had specialized in missiles, missile guidance and space penetration problems in each division were brought together to focus their combined skills on advanced concepts and systems. A new Division was created . . . the Missiles & Space Systems Division.

This division is only weeks old. It is in an explosive growth period. Yet it has a built-in stability factor . . . the advantages of the brainpower, the "know-how", the financial resources and the unique facilities of a billion-dollar corporation that is already pre-eminent in aeronautics.

This combination of newness and stability should be significant to every alert engineer or scientist. It should suggest a unique opportunity to demonstrate ability and win the advancement and other rewards that ability deserves.

If you are looking for opportunity, we suggest that you contact us immediately.

Positions are available at all levels in . . .

ELECTRONICS: Guidance, Radar, Countermeasures, Computers, Telemetry • SYSTEMS ANALYSIS • SYSTEMS INTEGRATION • MILITARY REQUIREMENTS • RELIABILITY • GROUND SUPPORT • SPACE TECHNOLOGY: Astrophysics, Astronautics • AERONAUTICS: Preliminary Design, Performance, Aerodynamics, Structures, Propulsion.

Please send your complete resume, including salary requirements, to Mr. John B. North.

MISSILES & SPACE SYSTEMS DIVISION
UNITED AIRCRAFT CORPORATION • EAST HARTFORD 8, CONNECTICUT

new missile products

High Temperature Cathode Ray Tubes for Radar

Cathode ray bulbs made of optical quality high temperature alumina-silicate glass are now available from **Corning Glass Works.**

Virtually free of physical imperfections, the bulbs are particularly applicable to high resolution radar surveillance systems. Alumina-silicate glass can be optically melted. Flaws can be held to .001 of an inch or less in size.

The glass withstands tube processing and/or operating temperatures up to 700C. It is ideally suited for applications where, as in cathode ray tubes, extremely high temperatures are required in screen-baking transparent phosphors to the faceplate.

Alumina-silicate glass is resistant to radiation, and has good thermal shock resistance and good electrical properties.

Circle No. 225 on Subscriber Service Card.

Subminiature Terminal Facilities Available

Twelve subminiature Teflon terminals are comfortably accommodated on a dime. **Sealectro Corp.'s** "Press-Fit" type FT-SM-125 feed-thru has a new truncated end for one of the two lugs, acting as a stop to prevent wrapped wire leads from slipping off until they can be soldered. The other lug is the usual plain pin.

Type FT-SM-125 measures .306" in overall height. It fits into a .081" diameter hole, and can be accommodated in any chassis up to .035" thick. It is available in code colors including red, blue, yellow, green, brown, orange, gray, purple and black, as well as white.

Circle No. 226 on Subscriber Service Card.

Spectrum Analyzer Model Is Marketed

B & K Instruments, Inc., Cleveland, Ohio, is marketing a new audio frequency spectrum analyzer featuring true RMS, average, and peak readout, switch selected. It is of the 1/3 octave type with center frequencies ranging from 40 to 32,000 cps. Additional low range filters are available.

Characteristics of the 30, 1/3 octave filters are: tops flat within ± ½ db; steep sides with maximum slope of 120 db per octave; skirt selectivity greater than 50 db per octave and greater than 70 db per 2 octaves from the center frequency.

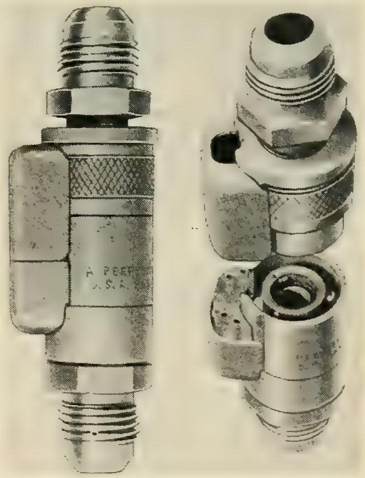
Spectrum analyses are automatically plotted on a frequency-amplitude calibrated chart when this analyzer is associated with the B & K instruments, Model 2304 Level Recorder.

Circle No. 227 on Subscriber Service Card.

Combination Electrical And Oxygen Disconnect

A new combination electrical and oxygen quick coupling from **Perfecting Service Co.** supplies necessary oxygen, electrical heating and communications through a single unit. This feature reduces connecting or disconnecting time and the number of lines an operator would have to handle.

The coupling is small and weighs one and one-half ounces. It is designed so that when connected, the seal will engage before electrical contracts are made, and conversely when disconnected. This feature makes the coupling applicable with inert gases, inflammable gases and all types of oxygen service.

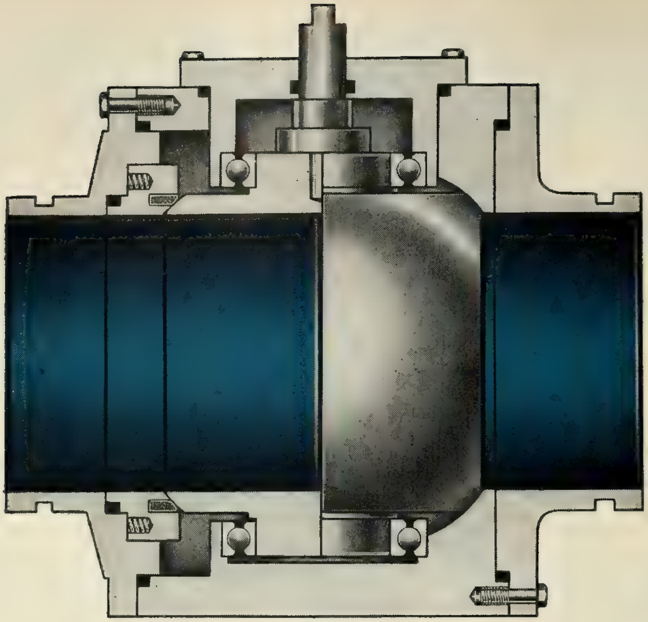


Fast, easy, one-hand patented "Pulomatic" action is featured. It locks automatically—without turning or twisting and forms a positive leakproof connection. Flow: 27 CFM at

NOTE: *For additional information about any product mentioned in this section of Missiles and Rockets use the attached prepaid reply cards. Circle numbers shown on the reply card that correspond with numbers appearing beneath items described. If no circle number accompanies the article or advertisement, give page number (and advertiser's name) on line provided at bottom of the card.*

Your requests for information will be forwarded promptly to the companies concerned.

The Editor



HYDROMATICS *FLO•BALL*® VALVES

The accepted standard of maximum performance and reliability

100% FLOW EFFICIENCY

Hydromatics' exclusive FLO•BALL design provides a straight-thru unrestricted fluid path, exactly equal to the pipe line diameter.

PERFECT SEALING

Zero leakage is assured through the use of a precision ball—the ideal geometric form for perfect sealing contact.

LOW OPERATING TORQUE

Ball rotates in precision bearings which absorb all pressure loads. Pressure balanced valve seat further minimizes forces on ball, reducing frictional drag.

LONG LIFE

Seat is always in sealing contact with the ball surface, resulting in a self-wiping, self-lapping action that insures long, trouble-free life.

HIGH SPEED ACTION

Only 90-degree rotation is required to fully open or close valve. Full travel as fast as 5 milliseconds.

RELIABILITY

Simple construction, with only one rotating part, provides built-in reliability and rugged, dependable operation.

CRYOGENIC AND CORROSIVE APPLICATIONS

Hydromatics' FLO•BALL valves, with new diaphragm sealing and unrestricted fluid path, have been proved the best valves for operation with LOX, Liquid Nitrogen, Helium, Hydrogen Peroxide, Red Fuming Nitric Acid and Hydrazine.

MODULAR ARRANGEMENT

Only FLO•BALL design, with its rotating valve action, permits side-by-side grouping of several valves, all driven simultaneously by a single actuator.

VERSATILITY

Only FLO•BALL design makes possible the interchanging of manual, motor or pressure actuators without changing the valve body.

HYDROMATICS, the world's leading designer and manufacturer of high performance ball valves for military and industrial applications, offers the most extensive selection of designs to meet all your requirements; Manual, motor or pressure operated. For cryogenic, corrosive or general service media. Pressures from vacuum to 10,000 psi. Sizes from ¼ inch to 12 inches.

Hydromatics, Inc.
70 Okner Parkway, Livingston, New Jersey

Hydromatics, Inc.

HYDROMATICS FIELD ENGINEERING OFFICES:

Pasadena, 35 N. Arroyo Pkwy., RYan 1-7448 / Denver, 829 15th St., AMherst 6-2714 / Washington, 1413 K St. N. W., STerling 3-3612

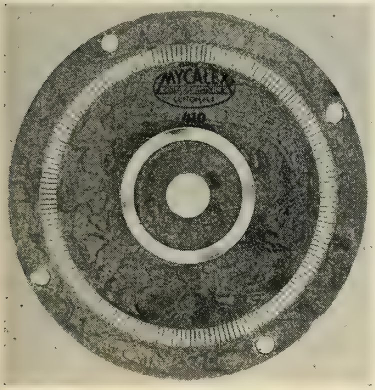
90 psi. Operating pressure to 250 psi. Temperature: Minus 85° to 300°F.

Coupling will deliver 150 liters of oxygen at 90 psi with less than one pound pressure drop.

Circle No. 228 on Subscriber Service Card.

New Mold Design For Commutation Plates

Supramica 555 ceramoplastic commutator plates provide new standards for the molding of dimensionally accurate electronics parts containing inserts. The new development, by **Mycalex Corp.** of America, has mold accuracy of ±1 minute in the positioning of rectangular inserts.



The commutator plate produced by the application of these new techniques is for a low noise level, telemetry switch. 180 contacts providing 90 individual pulses in a contact ring 2½ inches in diameter, with contact size .030″ diameter.

The Supramica 555 ceramoplastic commutator plate produces low level signaling unattainable with any other type of plate, and has the added advantages of accurate reproducibility, permanent dimensional stability and anticipated operating life of over 500 hours at 600 rpm.

Circle No. 229 on Subscriber Service Card.

Precision Potentiometer Available In Miniature

The Model 1410 Helical Potentiometer, manufactured by **S. A. Asquith Co.,** is a 1 watt, 200 to 25,000 Ohms Pot for use where the handling of a multiplicity of circuits in the smallest possible panel area is required.

The shaft, front bushing and bearing of the Model 1410 are manufactured from corrosion resistant nickel silver (18% Ni). Wiping contacts are fabricated from noble metal laminates. Bearings are provided front and rear and the shaft and wiper are electrically isolated. The stop mechanism is associated only with the shaft, permitting rotational accuracies otherwise impossible in so small an instrument. Stop strength is better than eight inch-pounds. The shaft does not move axially in and out with rotation.

The Model 1410 will withstand accelerations of up to 50 G's in three planes without electrical or mechanical damage and without wiper deviation from a set mechanical angle. Due to the balanced design of the wiper system, shaft locks are not necessary under any normal service conditions.

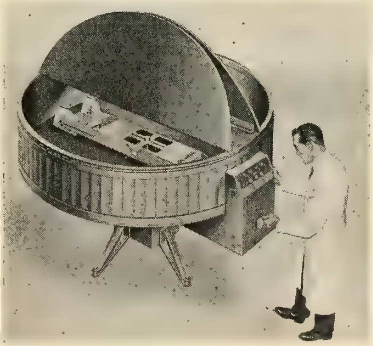
Circle No. 230 on Subscriber Service Card.

New Simulation Table Hydraulically Operated

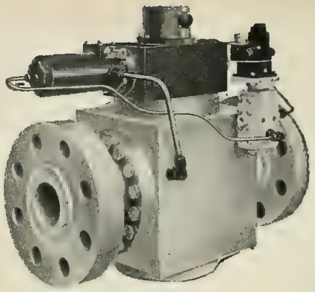
A single-axis flight simulation table for testing components under simulated pitch, yaw and roll maneuvers has been announced by **Genisco, Inc.**

The Genisco A916 Single-Axis Flight Simulation Table may be used with an analog computer, function generator, tape recorder, and digital-to-analog converter to evaluate autopilot systems and to determine the dynamic characteristics of high performance gyros and accelerometers. Characteristics, such as threshold, static friction, and non-linear behavior can be determined with accuracy.

Actuation of the table is accomplished hydraulically. Two pistons operate in a push-push configuration controlled by a high-gain servo system. Since the actuator is symmetrically located about the table axis of rotation, a uni-directional restraining force eliminates any possibility of mechanical backlash and allows continuous control in the operation of the close-loop servo system.



Circle No. 231 on Subscriber Service Card.



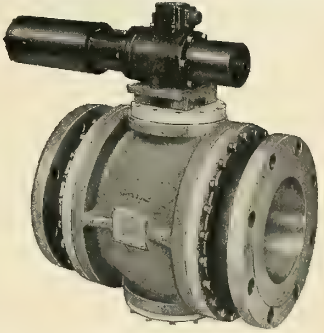
FAST-ACTING 3″ FLO•BALL VALVE
7 millisecond operation at 4000 psi

Pressure actuated 100% flow efficiency ball valve opens or closes a 3″ line in only 7 milliseconds, working against 4000 psi liquid or gas pressure at temperatures up to 250°F.

The fast action results from a built-in high pressure air accumulator, controlled by an integral explosive squib pilot valve. A low amperage electrical impulse sets off the squib, opening the accumulator allowing air pressure to actuate the valve. The cycle is accomplished in ***7 milliseconds.***

The unit includes a built-in motor operated 4-way selector valve, used to simplify accumulator recharging and also to recycle the valve. Accumulator may be charged prior to actual valve operation and then stored for up to one year without recharging.

Valves are being used for fast, precise flow control in high pressure missile and aircraft fueling systems, catapult launchers and emergency extinguisher systems.



6″ LOX FLO•BALL VALVE
100% flow efficiency,
minimum size and weight

Pressure actuated ball valve, designed expressly for LOX flow control in airborne and ground support applications. The sealed double-acting actuator, specially developed by Hydromatics, is thermally isolated from the valve body to guarantee fast, positive action at extreme low temperatures. Operating times from 30 milliseconds to 2 seconds, at 150 psi rated line pressure.

Valve includes a sealed, rotary action snap switch for remote observation of the valve position. Switch design allows external adjustment.

To facilitate installation and maintenance, the flanges are removable and interchangeable.

Hydromatics, Inc.

70 Okner Parkway, Livingston, New Jersey

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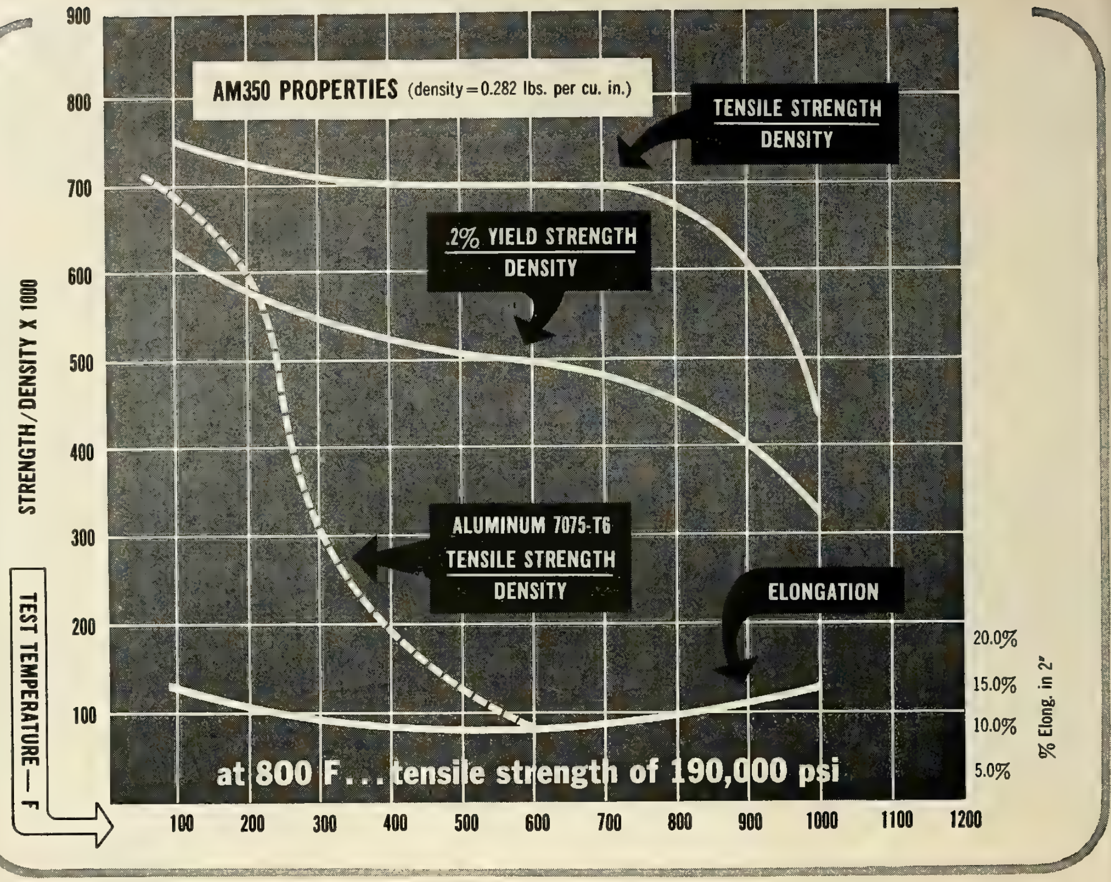
Experience**—the extra alloy in **Allegheny Stainless



Here are the facts on AM350 and AM355, Allegheny Ludlum's precipitation hardening stainless steels

A unique combination of highly desirable properties is the usual description of Allegheny Stainless AM350 and AM355 Steels. They combine high strength at both room and elevated temperatures, excellent corrosion resistance, ease of fabrication, low temperature heat treatment, good resistance to stress corrosion.

They are proving the answer to many problems of the air age. Airframe and other structural parts, pressure tanks, power plant components, high pressure ducting, etc. are all natural missile and supersonic aircraft applications for AM350 and AM355.

Availability: AM350, introduced several years ago, is available commercially in sheet, strip, foil, small bars and wire. AM355, best suited for heavier sections, is available in forgings, forging billets, plate, bar and wire.

Corrosion resistant: Being stainless steels, these alloys resist corrosion and oxidation. Compared to the older, more familiar stainless grades, their corrosion rating is better than the hardenable grades (chromium martensitic) but generally less than the old corrosion resistant standbys, the 18 and 8's. Stress corrosion is resisted at much higher hardness levels than with martensitic stainless.

Simple heat treatment: High strength is developed by two methods, both involving less than ordinary temperatures and minimizing oxidation and distortion problems. The most popular, and one that develops slightly better properties, is the Allegheny Ludlum developed sub-zero cooling and tempering (SCT condition). The material is held at minus 100 F for 3 hrs plus 3 hrs at 850 F. Alternate method is Double Aged (DA): 2 hrs at 1375 F plus 2 hrs at 850 F.

Easy fabrication: AM350 and AM355 can be spun, drawn, formed, machined and welded using similar procedures as with the 18-8 stainless types. In the hardened condition (SCT & DA) some forming may be done . . . 180 degree bend over a 3T radius pin. Also it can be dimpled in the hard condition to insure accurate fit-up.

For further information, see your A-L sales engineer or write for the booklet "Engineering Properties, AM350 and AM355." *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.* Address Dept. MR-11.

WSW 7327

ALLEGHENY LUDLUM

Export distribution: AIRCO INTERNATIONAL

EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

AL

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bolometers are considered as complete units consisting of a bolometer element in a suitable mount with a single pair of rf transmission-line terminals available for connection to the system.

A measurement, at the same frequency, of the reflection coefficient of an unknown bolometer is used to determine the reflected power. This, in conjunction with the previous measurement, can be used to determine the actual power absorbed by the bolometer, and hence, its efficiency.

The standard bolometers have been carefully designed, fabricated, elevated for all known errors, and calibrated in a microcalorimeter. All calibrations made by the center are in terms of these bolometers. Different standard bolometers are used for each transmission line size.

- **Microwave Frequency**—Frequency measurements for calibration purposes are made by direct comparison of the resonant frequency of a wavemeter cavity with the frequency of an accurately known signal (marker frequency). The basic reference standard for frequency measurements is a 100-kc signal obtained directly from the national standard of frequency. The 100-kc signal is multiplied through harmonic generation in conventional vacuum tubes and klystrons to provide several low-and high-frequency marker signals. These frequency marker signals become the references used in calibrating cavity wavemeters.

- **Microwave Impedance**—At present microwave impedance calibrations are not available at the Electronic Calibration Center. However, results of recent research in the Radio Standards Laboratory point the way to a calibration service, initially at X-band, within the next year, and work has begun on implementing this service.

Amphenol-Borg Merger Is in Planning Stage

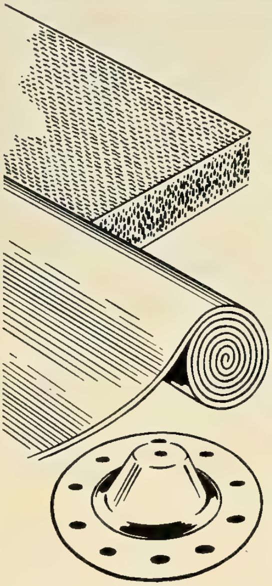
Directors of Amphenol Electronics Corporation, Chicago, and the George W. Borg Corporation, Delavan, Wisc., have approved a plan to merge the two companies.

The merger, which will be subject to approval at special stockholders' meetings to be held December 30, will result in the formation of Amphenol-Borg Electronics Corporation. Owners of Borg will receive one and one-third shares of Amphenol-Borg for each share now held; while the number of shares in the hands of Amphenol shareholders will remain unchanged.

The merged company will have

IN SILICONES OR RUBBER

WHAT'LL YOU HAVE?



SPONGE? Chemically blown, closed-cell silicone sponge is available in fine, medium, and firm density; skin thickness can be varied to suit. Excellent for gaskets, seals, shock mounts, light duty press pads, die cut parts.

SHEET? Solid sheet is produced from 1/32 to 1 in. thick, 20 to 80 durometer, in compounds to meet all AMS, ASTM, and military specifications. For gaskets, seals, bushings, die cut parts, diaphragms, heavy duty press pads. Laminated press pads and throw sheets are also available.

MOLDED PARTS? Diaphragms, pipe coupling gaskets, regulator parts, medical kit liners, bumpers, flexible coupling discs, spring inserts, aircraft test sleeves, and many other components are produced to rigid specifications.

Hewitt-Robins, prominent in development of aircraft refueling hose, makes many silicone and rubber products for the aircraft and missile industries. These components are fabricated using all elastomers, including silicones by themselves or with various fabric or metal reinforcements.

Specialists in our Aircraft Products Department can help you put today's new compounds to best use in aircraft, missiles, and rockets. For information, service, or your copy of comprehensive Product Bulletins, contact your local H-R representative, or Hewitt-Robins, Stamford, Connecticut.

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CONVEYOR BELTING AND IDLERS . . . POWER TRANSMISSION DRIVES
INDUSTRIAL HOSE . . . VIBRATING CONVEYORS, SCREENS & SHAKEOUTS

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This missile component is typical of structures now in production.

AERONCA brazed stainless steel structures

Working with existing fully-integrated facilities, Aeronca is producing and delivering a variety of brazed honeycomb sandwich components for aircraft and missiles. Flat, wedged, conic, contoured and compound curved configurations are produced *daily* by specialists in high-temperature structures.

Aeronca . . . a pioneer in stainless steel honeycomb development . . . is capable of designing, developing and producing any major airframe or missile component involving honeycomb sandwiches.

A technical team is available, on written request, to make specific presentations on Aeronca's facilities for high-temperature air weapon structures. Write today for additional information.

AERONCA manufacturing corporation

1716 Germantown Road • Middletown, Ohio

Expansion of our operations has created openings for additional senior engineers. Write to Mr. L. C. Wolfe, Chief Engineer.

8261-AC

Circle No. 23 on Subscriber Service Card.

over 7,500 shareholders, 3,500 employees, with annual sales exceeding $50 million and total assets exceeding $37 million.

Arthur J. Schmitt, president of Amphenol will be chief executive officer of the new company. The Borg firm, long known as a leading manufacturer of automobile parts, produces potentiometers and other electronic equipment which has become increasingly important in recent years and will supplement the broad Amphenol product line.

Amphenol Electronics, which last year celebrated the 25th anniversary of its founding by Schmitt, makes a wide variety of electrical connectors, coaxial cable, cable assemblies and harnesses.

In August, 1957, it acquired Danbury-Knudsen, Inc., of Danbury, Connecticut, which added to its product line in the connector and electronic specialty fields.

The George W. Borg Corporation was established in 1935 by Mr. Borg, one of the founders of Borg-Warner Corporation of Chicago. Mr. Borg will remain active in the Amphenol-Borg Electronics Corporation as a director and Chairman of the Executive Committee.

Lockheed Trains Navy Personnel on *Polaris*

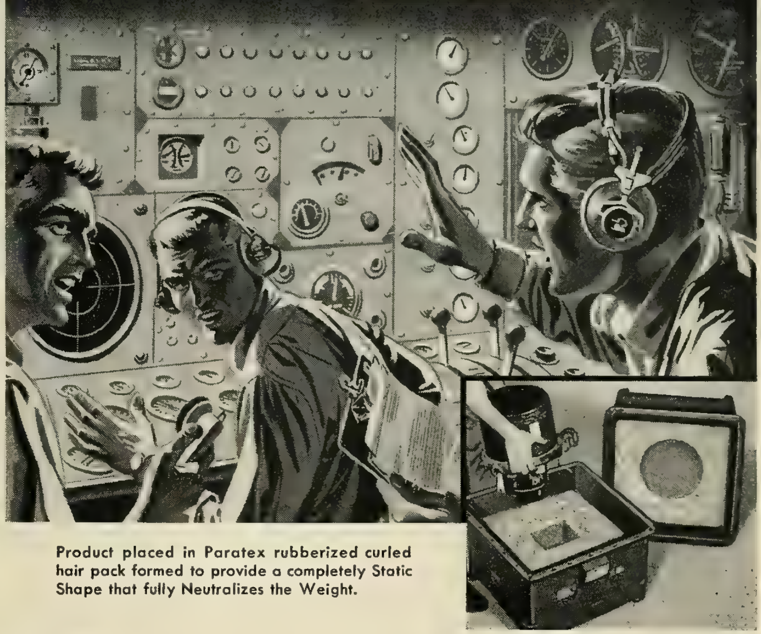
Planning to produce trained crews simultaneously with the *Polaris* missile system they will operate, Lockheed's Missile Systems Division is now pushing an intensive training program for a group of 78 Navy enlisted men and 6 officers.

Under its contract with the Bureau of Naval Personnel, Lockheed is responsible for training, either directly or through subcontractors, of specialist personnel. Training is being conducted at the company's Sunnyvale, Palo Alto and Santa Cruz Mountains facilities.

At the same time, the group is also receiving instruction in propulsion at Aerojet-General Corp.; in fire control at General Electric's Pittsfield (Mass) plant, and in launching systems at Westinghouse's Sunnyvale plant.

The trainees receive a week of formal classroom indoctrination from members of Lockheed's training and job analysis department; then begin on the job training, supplemented by classroom sessions.

Nine Fleet Ballistic Missile submarines are planned. With the normal complement of each submarine being 100 or more, Lockheed can be expected to eventually train more than 1,000 crew members.



Don't Be a Count-Down Casualty
11-10-9-8 HOLD...

Product placed in Paratex rubberized curled hair pack formed to provide a completely Static Shape that fully Neutralizes the Weight.

USE BLOCKSOM

Paratex

CUSTOM-CUSHIONING FOR PRODUCTS THAT MUST NOT FAIL

Don't let your product be a "count-down" casualty because of vibration damage. Blocksom Paratex cushioning safely cradles your product, practically eliminating shipping hazards that cause component malfunction.

CUSHIONING DESIGNED AROUND THE PRODUCT

For over 25 years, Blocksom engineers have been designing and developing special Paratex products to meet the rigid requirements of industry. The finished Paratex shipping pack combines the springiness of curled hair with the natural resilience of latex rubber which gives unsurpassed shock resistance, dampens vibration, is exceptionally light in weight, resists moisture, fungus, and is highly efficient at all temperature ranges. Results in safe arrival for your most delicate instruments.

PHONE COLLECT or WRITE TODAY for free consultation on your packaging problems

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in All Principal Cities

BLOCKSOM & COMPANY
Michigan City, Ind., Dept. MR11

☐ Send me folder on Paratex Packaging
☐ Have packaging engineer call

Name____________________
Company____________________
Address____________________
City__________ Zone____ State_____

Circle No. 49 on Subscriber Service Card.

NEW! AiResearch split-flapper check valve

The new AiResearch Split-Flapper Check Valve provides an exceptionally clean flow of any gas or liquid through the valve area. It achieves very fast closure with no leakage in the return flow.

This extremely compact, lightweight unit has important applications in petroleum, chemicals, paint, food processing, missile fuels . . . any industry with a gas or liquid flow problem. The valve can be made from various materials, covering an operational temperature range from cryogenic levels to 1700° F.

The AiResearch Split-Flapper Check Valve pictured above is made of aluminum...rugged and dependable with only two moving parts. Twin forged flappers, opening in the direction of normal flow, are supported through the center of the piping. In the event of backward flow, their spring mounting and aerodynamic design assure fast closure of the valve.

Insertion of short flapper plates through the bore eliminates exterior bonnet and gasket joint and reduces length. Other structural advantages are better support of the plates, greatly reduced shock loads on the hinges and sealing surfaces, reduced springload, less mass and material to be heated or cooled by the flow element.

Ideal for portable as well as stationary applications, the new AiResearch Split-Flapper Check Valve can accommodate lines 1 to 12 inches in diameter. AiResearch has 17 years of experience in the production of valves and controls.

Your inquiries are invited.

THE GARRETT CORPORATION

AiResearch Industrial Division

9225 South Aviation Blvd., Los Angeles 45, California

DESIGNERS AND MANUFACTURERS OF TURBOCHARGERS AND SPECIALIZED INDUSTRIAL PRODUCTS

west coast industry

by Fred S. Hunter

There are a number of reasons why the outcome of the Boeing Airplane Co.'s renegotiation case before the U.S. Tax Court is significant to the industry.

One, of course, is that there is no appeal from the decision. The U.S. Tax Court's word is final.

But more important is that the rate of profit which the court allows Boeing in this case may very well set a pattern for the industry. In other words, the companies will get a good idea of how much profit they will be allowed to make from here on out, or at least as long as we have renegotiation.

This is not to imply that if the court fixes a profit rate of, say, 8.6% for the Boeing company, it is going to fix the same 8.6% rate for some other company. Every renegotiation case is a different deal and is considered separately. Even for Boeing the court may establish a rate of profit for the year 1952, the year now under consideration, and change it for the year 1953 when the case for that year comes before it.

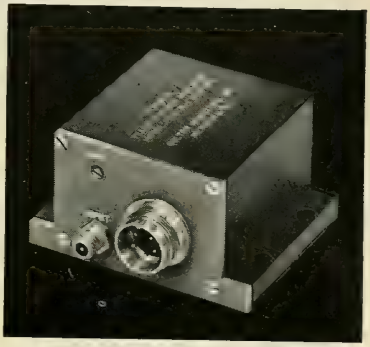
But it is highly probable that the rate of profit the court decides upon in the first air industry renegotiation case to come before it will be used as a guidepost in establishing rates of profits for Douglas or North American or any other company appealing the excess profit claims made by the Renegotiation Board.

From the strictly legal standpoint, the Boeing hearing in Seattle will set an important precedent in the ruling of the trial judge on evidence. While the decision which the court will hand down will be made by the entire bench of 15, only one judge sits at the hearing and rules on the evidence the company and the government are permitted to introduce.

All signs indicate that the Renegotiation Act is set for a going over from the next Congress. Originally designed to protect the government during the war period when military production consumed most of the nation's industrial capacity without competitive restraint, renegotiation was reenacted in 1951 during the Korean conflict and has since been continued in effect.

It has been assailed on all sides, by big business and by small business, by prime contractors and by subcontractors, as hindering cost reductions, impeding technological progress, penalizing efficiency and destroying incentive.

The Boeing company was the reestablished Renegotiation Board's first target. After having been "cleared" by the regional board for 1952, the Seattle manufacturer's return for that year was declared to have been excessive in the amount of approximately $10 million, before taxes, upon the determination of the national board. The following year Douglas, Lockheed, North American and others, as well as Boeing, were determined to have netted excessive profits on their military contracts.



28 volts powers this transistorized vibration amplifier

Consuming only a fraction of the power required by tube type units, taking ⅓ the space, and operating directly from a 28 volt battery, this GLENNITE transistorized amplifier fills all requirements for airborne application.

Unique design and rugged construction assure extremely low microphonics, provide high input impedance for direct use with piezoelectric accelerometers.

A companion light weight, 3-channel battery pack is available. This unit contains a rechargeable, sealed nickel cadmium battery capable of powering 3 transistorized amplifiers for 16 hours.

Like more data on these units? Contact your local Gulton representative, or write us direct.

SPECIFICATIONS

Gain: Continuously variable from 10 to 100
Input impedance: 30 megohms minimum
Power input: 28 v dc at less than 3 ma
Frequency range: 10 cps to 20 KC
Temperature range: up to 200° F

Call in Gulton

Whether you need a single instrument or a complete system, Gulton is capable of meeting all your needs in shock and vibration measurement from transducer to readout equipment. Call in a Gulton Instrumentation Engineer on your next assignment — or on your present one if you have a problem.

GULTON INSTRUMENTATION DIVISION

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Metuchen, New Jersey

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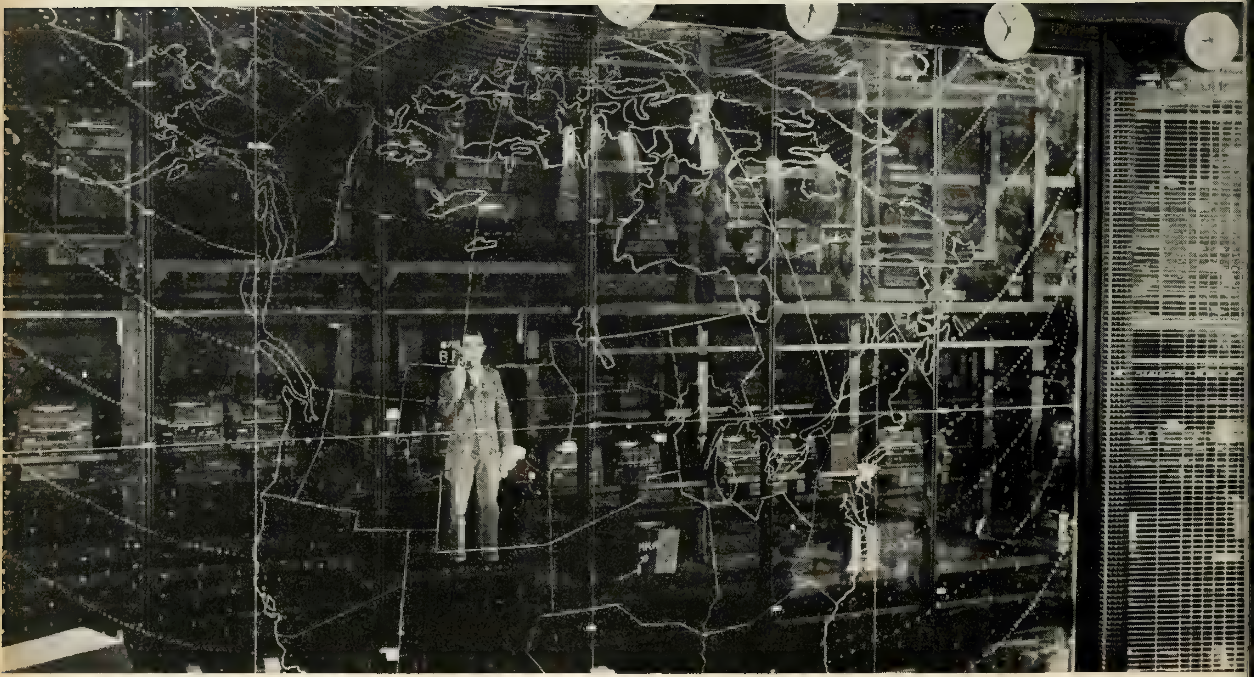
Preserver of Peace . . .

NORAD

Wrap-around bumper for a continent



Headquarters—NORAD—Colorado Springs

Like a huge "bumper" wrapped around the North American continent and reaching down along both the Atlantic and Pacific shores, the North American Air Defense Command (NORAD) has been created for operational control of air defense units of the Army, Navy and Air Force of the U.S. and the RCAF Air Defense Command of Canada. Its field includes the vast area between the southern border of the United States and the northernmost limits of Canada and Alaska. Under the functional control of NORAD will be BMEWS (Ballistic Missile Early Warning System) and SAGE (Semi-Automatic Ground Control Environment) for the defense of specified sectors. In addition to its responsibility as prime contractor for BMEWS, the Radio Corporation of America is working on other important electronic assignments for NORAD.

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DEFENSE ELECTRONIC PRODUCTS

CAMDEN, N. J.

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world astronautics

by Frederick C. Durant III

The first interplanetary probes may not be launched until the 1960's. Much thought has already been given to the most significant measurements that might be telemetered by rockets to the vicinity of the planets. Venus and Mars will be the first planets to be studied. Mercury is too hot and the others are too far away. Early probes will simply pass (hopefully) within a few hundred miles of the target or, possibly, impact on the surface. More sophisticated systems with course-altering rockets will be used as inertial guidance systems with fantastic accuracies by today's standards.

The mass of the planets can be determined from trajectory deviations of the probe itself as it nears the body. For eventual sophisticated systems, astronomer Gerard de Vaucouleurs of Harvard College Observatory has suggested three different observation methods: optical, spectroscopic and radio.

For Venus, radio ranging could determine the depth of the atmosphere cloaking the planet from view and the true diameter of the globe. High dispersion spectra of the upper atmosphere and radio sounding for possible ionosphere are also suggested.

Since we know much more about Mars, more detailed studies can be expected. Optical observations would be particularly interesting. A 10-inch telescope at 1,000 miles above the surface could, according to de Vaucouleurs, show "spots as small as 100 ft. in diameter or lines 25 ft. in width." Such observations would possibly solve existing hypotheses on canals, volcanoes, polar caps and vegetation.

Spectroscopic tests of Martian atmosphere could be carried out between two ships, or one ship and a reflecting mirror. Spectra from surface reflected light, especially in the infrared, of the dark areas could be used for the detection of weak but significant bands; e.g., OH bond absorption.

Radio observations might include continuous ranging in closed orbit for surface relief, completely unknown at present. Variable frequency sounding would detect an ionosphere or ionized layers. Other desirable measurements would be magnetometer mapping of the general magnetic field and the firing of smoke-trailing rockets into lower atmosphere for wind studies.

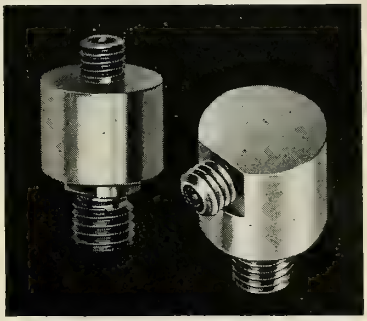
An interesting point of relative emphasis may be found under the heading *Rocket* in a well-known one volume encyclopædia published in 1950. Two 19-line paragraphs describe the word "Rocket." One description commences, "Projectile propelled by a force within itself . . . etc." The other, equal length paragraph, which appears *first,* commences, "Popular name for several plants of the mustard family . . ."!

Plastics for high temperature use have been delineated by General Electric Co. Conclusions are applicable to missile skins, plastic motors, blast tubes, nozzles, and parts for plasma jets. High carbon plastics—particularly pheonolics, are good. Reinforcing fiber orientation should be random. Up to 3,000°K silica fibers are better than glass. Nylon fibers erode less than glass, however. Other organic fibers may be better than either. High glass fiber content give higher mechanical strengths, but cutting down on fiber at rocket plasma jet temperatures eases thermal erosion.

Solid propellant extrusion studies conducted by Naval Ordnance Test Station at China Lake indicate that it is safer and more economical to use several small presses than one large unit. Cylinder diameter doesn't limit grain size too much. Tests were carried out with N-4 double base propellant.

Latest hot fuels for ramjets at high altitudes are the organic sulfur compounds such as carbon disulfide or dimethy sulfide. Most give high flame speeds and offer unusually high altitude blowout resistance.

Avoid false test results with GLENNITE internally ungrounded accelerometers



Now you can avoid one of the major causes of false test results – spurious "ground loop" voltages – by using *internally ungrounded* GLENNITE accelerometers.

These units contain sensitive seismic elements *internally* insulated from the mounting stud by rugged ceramic insulation. You can employ a *single point ground* at the data handling or recording equipment by using a combination of these accelerometers with ungrounded GLENNITE amplifiers and filters.

GLENNITE accelerometers are available in uni- and triaxial models – wide acceleration and temperature ranges.

A complete line of associated ungrounded electronic equipment includes filters, amplifiers, connectors and other related units.

For complete data on Gulton instrumentation systems – grounded or ungrounded – contact your local Gulton representative or write us direct.

Call in Gulton

From transducer to readout, Gulton is capable of meeting all your instrumentation needs. If you have a measurement problem, why not call in a Gulton Instrumentation Engineer. His broad experience in shock and vibration measurement can prove invaluable to you.

GULTON INSTRUMENTATION DIVISION

GI

Gulton Industries, Inc.

Metuchen, New Jersey

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To a man floating weightless around Space Station C, these are perhaps meaningless words—but *solid footing* is highly important to most of us who live and work on the surface of the earth.

Autonetics has established a solid footing in inertial guidance through 12 years of successful development and production of airborne and ocean-going systems, as well as systems for space applications.

The healthy growth of the Autonetics Guidance Engineering department—based on a number of highly diversified contracts—has created new senior-level positions in the fields of electro-mechanical component development and system analysis.

Well qualified, experienced men will find solid footing in this permanent, progressive, and successful organization—plus the chance to create and to grow in one of today's most challenging fields.

But time's a-wasting. *Now* is the time to find out what the future holds for *you* at Autonetics.

Please send your resume to Mr. N. L. Benning, Manager, Employment Services, 9150 E. Imperial Highway, Downey, California.

NERVE CENTER OF THE NEW INDUSTRIAL ERA **Autonetics**
A DIVISION OF NORTH AMERICAN AVIATION, INC.

. . . Hoover profile

(Continued from page 18)

and we used a steering wheel similar to that on a car," Hoover predicts, "anyone would be able to fly a plane or a space ship."

This system, Hoover says, would eliminate practically all instrument training, reduce accidents caused by misinterpretation of instruments and would lower costs of air and space vehicles. He points out, as an example, that some aircraft use as many as 13 gyros, each part of a subsystem; whereas the new system would use only one, with possibly an alternate standby.

Although the complete integrated system will not be ready for flight until about 1965, early versions will probably appear by 1960 and 1961. Meanwhile, interest is high in both industry and the services.

Dan Beard, assistant vice president of Equipment Research for American Airlines, calls the new concept "one of the most interesting developments to come along to simplify the pilot's job."

Beard, who has "flown" with the contact analogue in a Douglas simulator, said AA thinks it will have great value for easing the traffic control problem. "However," he added, "this is a revolutionary idea, and although it might possibly replace most of our present instrumentation, it will take time for this idea to sink in, as it did for our present system."

A spokesman for the Army Signal Corps Research and Development Laboratory, which has let a contract for development of the system for helicopters, and has observed and participated in tests, says:

"It certainly looks good to us. We are optimistic that it will pan out and if it does, it will accelerate, simplify and reduce the cost of training pilots."

Although Hoover's proposal is formally blanketed under the Army-Navy Instrumentation Program, the Air Force, which is studying less comprehensive instrument improvement projects, is watching progress on the concept carefully.

One underlying but significant aspect of the Hoover approach to the instrumentation problem was pointed out by AF Col. Taylor Drysdale, chief of Research and Analysis Division, Directorate of Development Planning.

"Fundamentally, the most important thing about Hoover's proposal is the principle of it with respect to research and development planning guidance. Instead of proceeding in basic and applied research through the hit or

(Continued on page 81)

Smaller, Stronger Fasteners for the Aircraft Industry...

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Where you need the strength of a solid rivet—in those impossible, blind installations—the new Cherry 3/32" Self-Plugging Rivet is the answer.

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For technical information write to Townsend Company, Cherry Rivet Division, P.O. Box 2157-Z, Santa Ana, California.

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research for rocket fuel control

Pumps, turbines, cryogenic hardware and fuel systems—everything short of firing the rocket—will soon be tested by a CEC process control system. Working with dangerous propellants and limited time, the system will provide complete, automatic programming, rapid control, and data in 30 seconds. Write for the complete story in Bulletin CEC 3016-X1.

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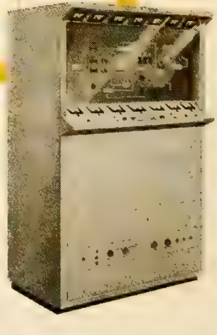
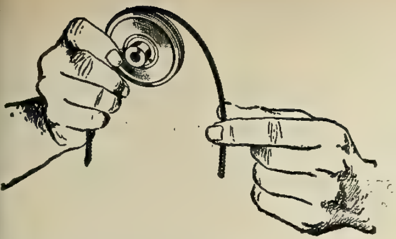


From a central block house, the operator controls and reads air pressure, exhaust temperature, turbine speed, flow rate, pump suction pressure, and receiver tank pressure. The system automatically corrects for rates of change of test parameters to insure maximum data in limited time.



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miss method, you proceed rationally in accordance with a rational design.

• Schoolhouse R&D—Seeking basic causes began in grade school for Pennsylvania-born Hoover. His mother made many trips to consult with teachers who complained that young George would not accept their teachings without continually asking "why?"

Hoover states matter-of-factly that his mental acquisitiveness has been getting him in trouble periodically ever since. "This type of curiosity is almost like a sickness. Not in the sense of being ill, but you can't stop any more than you can stop eating. It is something you have to do. I have tried to forget trying to change things or trying to bring about anything new for short periods of time. I was completely upset. It is part of my basic nature."

The Commander knows well the frustrations that accompany this drive. A case in point was cancellation of *Project Orbiter,* the original satellite program which was scuttled in favor of the *Vanguard* project. This came as a stunning blow to the man who had babied the project from the time he called the first meeting with Dr. Wernher von Braun and other space scientists who agreed the project was feasible.

In an organization such as the Defense establishment where conformity is the rule, George Hoover's individualism sets him apart. Although he does not thunderclap his differences with established procedure or accepted doctrine, stepping on the toes of convention, however softly, does not endear him to the docile majority. There have been many battles with prevailing opinion and they have left scars. But the "basic nature" always bounces back.

• Space factors—A recent Hooverism questions the necessity for conditioning man to meet such hazards of space flight as weightlessness. "Why should we condition him" Hoover asks, "to make up for the deficiencies of the equipment? Why should man be weightless in space?

Man is always the guy who has to take the beating for the deficiencies of the equipment. And in space this cannot be. If you are going to put man out there, you have to give him the tools."

Although the manager of ONR's weapons systems accepts his apartness, he views with mixed feelings the fact that his 12-year-old son is heading in the same direction. "George has the same curiosity I do," Hoover says shaking his head. "I know what he's going to be up against."

Ground Support Package for Guidance Control

Designed and built by Pesco, working in close cooperation with FARNSWORTH ELECTRONICS CO., a complete "check-out" package assures accurate pre-launch testing of BOMARC's guidance control system. The motor-generator features a Pesco Permanent Magnet Alternator—of 1.0 kva, 400 cycle power output at 3,000 rpm. The entire package including motor generator, magnetic amplifier type of voltage and frequency controls is contained in two sliding rack panels. Frequency regulation: ±2%; Voltage regulation: ±1% over a load range from 50-100%. Pesco creative engineering is offered, without obligation, to solve your Ground Support Equipment problems. Please contact:

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high-energy fuel briefs from Callery

New HiCal plant dedicated at Muskogee, Oklahoma — The nation's first large-scale high-energy fuel plant was dedicated on November 1 by the Navy at Muskogee, Oklahoma. Callery built and will operate the $38-million plant for the Navy. When tonnage quantities of HiCal are produced at the plant next year, the high-energy liquid fuel will be used extensively in tests on various types of propulsion systems such as turbojets and ramjets. *Write for new Technical Bulletin, C-1110: HiCal-3 Compatability with Materials of Construction.*

Dayton, Ohio office opened by Callery — Fuel and propellant users in the Dayton area can now utilize Callery's newly opened office to obtain technical service on their growing needs in aircraft fuels and propellants: 2600 Far Hills Avenue, Room 12, Dayton 19, Ohio; telephone AXminister 3-2752.

New ignition-delay data on Triethylborane — Just published data (C. J. Marsel and L. Kramer, Supplementary Preprint of Papers, Seventh International Symposium on Combustion, 655-61, Sept. 3, 1958) on Triethylborane (TEB) ignition delays: 20 msec. at 5 in. Hg, 50 msec. at 2 in. Hg, and 40 msec. at 0.5 in Hg, with inlet air at 450°F. For JP-5-TEB mixtures at 450°F and 5 in. Hg, the delay is 170 msec. with 51.8% TEB and 200 msec. with 39.8% TEB; spontaneous ignition does not occur with 38.5% TEB.

TEB can be used as a pyrophoric ramjet fuel, as a reigniter for turbojets, and as an additive to improve combustion properties of JP and RP fuels. *Write for Technical Bulletin C-310 and Handling Bulletin C-311.*

R & D Lab employees earn another safety award — Employees of Callery's Research and Development Laboratories have earned two safety awards in the past year. Most recent achievement: 571,571 man-hours without a lost-time accident.

In the first six months of 1958, Callery's R & D employees have had one-third the number of accidents — and one-fiftieth the number of days lost from accidents — as the average of comparable chemical plants. *HiCal-3 Handling Bulletin C-1100 is available on request.*

Phone: FOrest 4-1130
TWX: Perrysville, Pa. 117

Anthony C. Hummel
Technical Representative
Defense Products Department
Callery Chemical Company

CALLERY
CHEMICAL COMPANY
9600 PERRY HIGHWAY
PITTSBURGH 37, PENNSYLVANIA

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contract awards

AIR FORCE

By Headquarters, Air Force Office of Scientific Research, ARDC, Washington, D.C.:

Syracuse University, Syracuse, N.Y. received $30,000 for research on the theory of irreversible processes.

Lockheed Aircraft Corp., Missile Systems Div., Sunnyvale, Calif., received $46,575 for research on the theory of composite propellant burning.

California Institute of Technology, Pasadena, Calif., received $38,500 for continuation of research on selected problems in microwave electronics.

The Catholic University of America, Washington, D.C. received $44,840 for research on electrochemical properties of metal-hydrogen alloys.

Carnegie Institute of Technology, Pittsburgh, Pa. received $48,863 for research on optical properties of metals and alloys.

The University of Michigan, Ann Arbor, Mich. received $27,150 for research on strong luminous shocks produced in shock tubes.

Cornell University, Ithaca, N.Y. received $84,873 for continuation of research on new solid state defect structures.

By Cmdr. Hdqrs. AMC, Wright-Patterson AFB, Ohio:

Sperry Gyroscope Co., Sperry Rand Corp., Great Neck, Long Island, N. Y. received $1,340,000 for AN/TPW-1 microwave command guidance equipment, range and tracking test sets, radar sets, services and data to be used in the development of the XQ-4A drone.

Northrop Aircraft, Inc., Hawthorne, Calif., received $850,000 for crew procedures trainer evaluators for the SM-62A weapon system.

By Headquarters AF Cambridge RCAR&DC, USAF, Laurence G. Hanscom Field, Bedford, Mass.:

Massachusetts Institute of Technology, Cambridge, Mass., received $4,500,000 for research services related to re-entry physics and instrumentation radar.

The Pennsylvania State University, University Park, Pa., received $75,000 for research directed toward investigation of the physics, dynamics and general properties of the ionosphere.

Brown University, Providence, R.I. received $49,982 for research directed toward the study of radiation of electromagnetic waves.

Dynatronics, Inc., Orlando, Fla. received $95,162 for a trailer, and portable field laboratory.

The G. T. Schjeldahl Co., Northfield, Minn., received $34,458 for design and fabrication of meteorological rocket balloons.

Massachusetts Institute of Technology, Cambridge, Mass., received $25,000 for research directed toward the understanding of hydromagnetic shocks.

Allied Research Associates, Inc., Boston, Mass., received $29,953 for aeronautical engineering instrumentation development.

ARMY

By U.S. Army Ordnance Dist., Phila., Pa.:

Western Electric Co. Inc., New York, N.Y. received 16 contracts totaling $997,395 for *Nike* spare parts & components.

The Johns Hopkins University, Baltimore, Md., received $13,500 for theoretical and experimental studies of plastic wave propagation in longitudinal rods subject to impact and $18,362 for research on the transient response of porous media and packed beds to large thermal and pressure fluxes.

NAVY

By Dist. Public Works Officer, Sixth Naval Dist., U.S. Naval Base, Charleston, S.C.

Nat G. Harrison Overseas Corp., Miami, Fla., received $313,300 for additional base facilities at Antigua Island, British West Indies for the Air Force Missile Test Center offshore facilities.

By the Navy Department, Bureau of Ships, Washington, D.C.:

Skagit Steel & Iron Works, Sedro-Woolley, Wash., received $299,691 for missile handling crane.

By the Navy Department, Bureau of Ordnance, Washington, D.C.:

Northern Ordnance, Inc., Minneapolis, Minn., received $521,000 for job orders in connection with the emergency repair, overhaul, maintenance of guns, gun mounts and missile launchers.

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Callery Chemical Co. 82
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Consolidated Electrodynamics Corp. 80
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CONVAIR, a Div. of
General Dynamics Corp. 61
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Craig Systems, Inc. 60
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Agency—Kirkgasser-Drew
Douglas Aircraft Co., Inc. 54
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Electrical Engineering & Mfg. Corp. 8
Agency—West-Marquis, Inc.
Ex-Cell-O Corp., Aircraft Div. 20
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Flexonics Corp. 47
Agency—Russell T. Gray, Inc.
General Electric Co. 59
Agency—G. M. Basford Co.
General Electric Co. 37
Agency—de Garmo, Inc.
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Aviation Products 3
Agency—Kudner Agency, Inc.
Gulton Industries, Inc. 75, 77
Agency—Marsteller, Rickard, Gebhardt & Reed, Inc.
Hewitt-Robins Industrial Products 71
Agency—Fuller & Smith & Ross, Inc.
Hexcel Products, Inc. 38, 39
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Hydromatics, Inc. 68, 69
Agency—Industrial Marketing Assoc., Adv.
Kearfott Co., Inc. 23
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Librascope, Inc. 6
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Linde Co., Div. of
Union Carbide Corp. 42
Agency—J. M. Mathes, Inc.
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Marquardt Aircraft Co. 44, 45
Agency—Grant Adv., Inc.
Millipore Filter Corp. 30
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Missiles & Space Systems Div.,
United Aircraft Corp. 66
Agency—G. F. Sweet & Co., Inc.
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Autonetics Div. 78
Missile Development Div. 31
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Pacific Automation Products, Inc. 27
Agency—Anderson-McConnell, Adv. Agency, Inc.
Pesco Products Div.,
Borg-Warner Corp. 81
Agency—The McCarty Co.
Precision Lapping Co., Inc. 24
Agency—Herbert Lindauer Assoc.
Radio Corp. of America 76
Agency—Al Paul Lefton Co., Inc.
Robertshaw-Fulton Controls Co.,
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Rockwell Standard Corp.,
Transmission & Axle Div. 56
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Servomechanisms, Inc. 2
Agency—Sanger-Funnell, Inc.
Simmonds Aerocessories, Inc. 32
Agency—Burke Dowling Adams, Inc.
Statham Instruments, Inc. 34
Agency—Getz & Sandborg, Inc.
Stromberg-Carlson Co., Div.
General Dynamics Corp. 51
Agency—The Rumrill Co., Inc.
Telecomputing Corp. 40
Agency—Anderson-McConnell Adv. Agency, Inc.
Teleflex, Inc. 81
Agency—John T. Hall & Co.
Templet Industries, Inc. 43
Agency—Richard & Gunther, Inc.
Townsend Co., Cherry Rivet Div. 79
Agency—Bond & Starr, Inc.
Vickers, Inc., Div., Sperry Rand Corp. 35
Agency—Witte & Burden.
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Air Arm Div. 25
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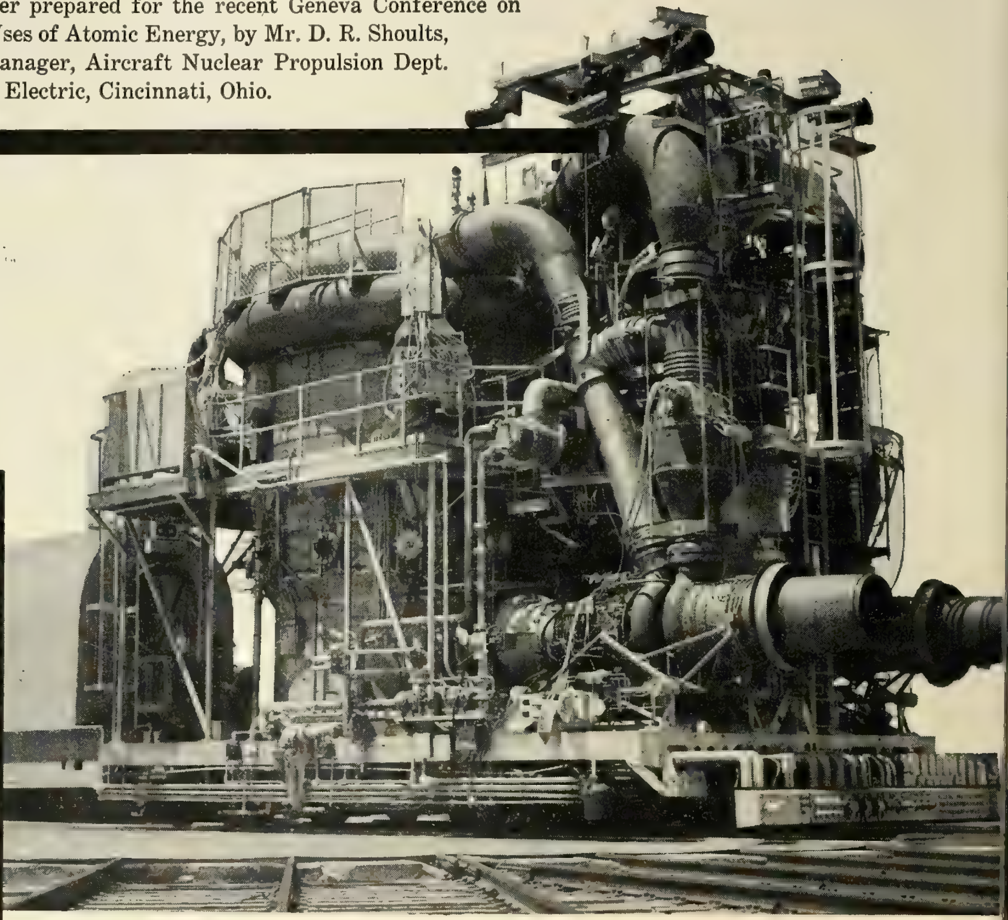
ENGINEERS, SCIENTISTS: Specific Experimental Data have now been declassified from which you can gauge the breadth of the opportunities for original work open to you in the pioneering field of nuclear power for aircraft. This information is made available from a paper prepared for the recent Geneva Conference on Peaceful Uses of Atomic Energy, by Mr. D. R. Shoults, General Manager, Aircraft Nuclear Propulsion Dept. of General Electric, Cincinnati, Ohio.



Test Assembly for HTRE No. 1 to the right is on its way to test area on a flat car, drawn by a shielded locomotive. Test area control center itself is underground for safety considerations. During test period, the *Direct Cycle Nuclear Turbojet System* was shut down between operating phases and the Test Assembly returned to the "*Hot Shop*" (a chamber with 7 ft. thick concrete walls and 6 ft. thick windows) where remote handling equipment, designed for this program, disassembled components for the inspection or replacement of parts.

FIRST PHOTOGRAPHS, DIAGRAMS AND TECHNICAL DATA RELEASED ON HISTORIC TESTS PROVING FEASIBILITY OF DIRECT CYCLE NUCLEAR TURBOJET SYSTEM FOR AIRCRAFT

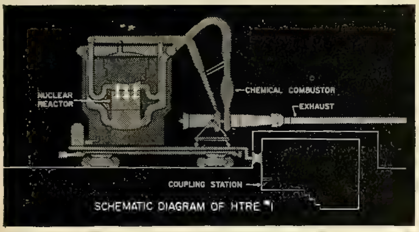
Successful Heat Transfer Reactor Experiment No. 1 Basis of Present Advanced Development Stage of Aircraft Nuclear Power Plant

HTRE No. 1 marked *the first time* that all the components of a combined reactor and jet engine power plant were assembled and operated.

The system was developed and produced by General Electric engineers and scientists at the Aircraft Nuclear Propulsion Department, Cincinnati, Ohio, under dual contract with the U.S. Air Force and the U.S. Atomic Energy Commission. The tests were conducted at the National Reactor Test Station in Idaho Falls, Idaho, during the period January 1956-January 1957.

"These tests," Mr. Shoults writes, "were of great significance in meeting the objective of developing a useful aircraft nuclear propulsion system. HTRE No. 1 proved conclusively the operability of the system and the predictability of its performance."

The Test Assembly for the experiment consisted of an air-cooled, metallic-fuel-element, water-moderated reactor operating a modified J47 turbojet engine designated X39. *A photograph of this assembly is reproduced at the left; schematic diagram below shows a simplified version of the air flow path through the system.*

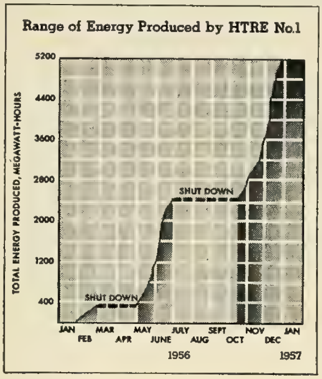


Test Assembly utilizes the direct air cycle to which propulsive thrust is provided by sending atmospheric air from the compressor (compressed to 5 times the intake pressure) directly through reactor, into the turbine, and out exhaust nozzle.

The reactor core structure consists of a cylindrical water vessel penetrated by air tubes. The shield plug structure and the heavy gamma ray shielding are of stainless steel. Moderator water is used for neutron shielding in shield plug.

The power plant is started on chemical fuel alone, with compressor air passing through the cold reactor. As the reactor power increases, the chemical fuel flow is decreased. When nuclear power is sufficient for self-sustaining operation, chemical fuel is cut off.

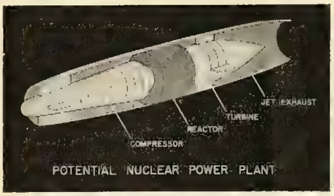
Throughout the tests, operation was stable during the transition from chemical to nuclear power and the reactor was responsive to both manual and automatic control. Combined operating time during test period totalled 258 hours. *A chart showing total energy produced in test period is reproduced below.*



Confirmation of Design Concept of Direct Cycle Nuclear Turbojet System Obtained

Extensive operation at full nuclear power was recorded without failure or significant leakage of radioactive material to the airstream. Proof was obtained that overheating portions of the reactor would not lead to local flow starvation and progressive overheating.

Much of the apparatus illustrated was provided for developmental convenience and would not be used in an actual system for aircraft. The shield, for example, is extra-heavy to allow external contact maintenance during shut-down. In an aircraft installation the shield would be much lighter and the engine would be coupled more closely to the reactor-shield assembly. *A diagram of a potential configuration for a Direct Cycle Nuclear Turbojet System for airframe application is shown below.*



2nd and 3rd Generation Nuclear Power Plants for Aircraft Now Under Development

Research and development has proceeded at an accelerated pace at General Electric, since the epochal results of HTRE No. 1 in early '57.

The great challenge of the aircraft nuclear propulsion project is that this type of system requires generation of large amounts of heat from a nuclear reactor of very small volume. Also, all items comprising the power plant must be provided within very stringent weight limitations.

Intensive work has been — and is — under way in areas of reactor design, shield design, and the development of new materials to withstand extreme temperatures and neutron bombardment, as well as new methods of fabricating these materials.

While much progress has been made, many problems must still be solved before the first high performance aircraft flies on nuclear power.

ENGINEERS and SCIENTISTS:

If you are interested in joining the professional staff now working in breakthrough areas on the Aircraft Nuclear Propulsion Program at General Electric — and have the necessary qualifications for any of the technical fields described below — *your inquiry will be welcomed.*

A majority of these openings do NOT require previous nuclear experience.

Openings for **METALLURGISTS; CERAMISTS; MATHEMATICIANS; MECHANICAL, ELECTRICAL, AERONAUTICAL AND CHEMICAL ENGINEERS; NUCLEAR AND SOLID STATE PHYSICISTS; PHYSICAL CHEMISTS** *to work in the following areas:*

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Write in confidence, including salary requirements: to Mr. P. W. Christos, Room 43-WT

AIRCRAFT NUCLEAR PROPULSION DEPARTMENT

GENERAL ELECTRIC

P.O. Box 132, Cincinnati 15, Ohio

Let's Do Something About Education, Now!

If there has been any doubt as to the seriousness of the shortage of trained U.S. technical personnel, a study of two articles in m/r (Oct. 6 and Oct. 27) should remove further questions.

When it becomes apparent that companies are forced into actual purchase of technical know-how in an ever-rising market, it's time to do something.

This shortage of trained people isn't new. It has been with us—and has been recognized by technical societies and the educators—since the end of World War II. A tremendous flood of verbiage has flowed across the pages of the business and general press concerning this subject. More words have filled the ears of listeners at endless conventions and meetings.

The government, at the past session of Congress, took some action—but not very much. And little else has been done where it counts.

The eventual remedy, of course, is at the level of the technical schools—and certainly every encouragement should be given to them to train new people. But closing the gap by this means is too slow a process—it takes at least five years of schooling and experience to train a college-age youngster to a point where he can be called well grounded technically.

A remedy is needed, and it is needed right now.

And there is a way to do it, right now.

That way is for industry—collectively and individually—to take hold and do the job. It is industry that needs the people, and industry which must set the standards of training.

Many industrial organizations have made stabs at the problem on an individual basis, with in-training programs, small grants to universities, scholarships, and the like.

But it is time for industry to work together on this—through existing national organizations like the U.S. Chamber of Commerce, the National Association of Manufacturers, the Electronics Industries Association, and Aircraft Industries Association.

A program might be worked out this way:

The various industry groups could appoint a central committee, representing all of them.

This committee could first determine what industry's needs will be for technically-trained people over a period of many years.

It could then break down the overall need to specifics—how many chemists, how many electrical engineers, how many physicists.

Next step could be a census of how many of these people are now available, or will become available through graduation or experience, within the specified period. This census should be broken down to include age and experience, so that some measure can be taken of the natural attrition that will occur.

One further breakdown should be made: How many of the needed people must be college-trained with degrees, and how many can be trained in technical schools or on-the-job training courses for less technical work.

And while industry is at it, it might make a further census of another large reservoir of skill—the ranks of men and women who have been retired, but whose knowledge might still be tapped.

With this kind of information in hand, a united industry front could attack the problem several ways:

- It could aid the schools with direct grants of money.
- It could aid the schools by lending some of its own top personnel to help hard-pressed teaching staffs.
- It could provide intensive and better planned on-the-job training programs, centrally supervised, and if need be, following a broad general teaching plan.
- It could make provision for re-training, or at least refresher training, of men already on its payrolls.
- It could work with labor organizations to spread the training further down the ranks, so that another potential reservoir of replacements could begin training.
- It could work with the military in these programs, so that military and civilian training would be along the same lines, and civilian and military personnel could understand mutual problems.
- It could advise government agencies in their efforts to help.

Only by such a concerted effort can the U.S. hope to provide enough of the right people at the right time to keep our missile and space programs—as well as other endeavors based on science—rolling and producing results.

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For additional information about any product or service advertised or mentioned in the editorial pages of this issue of Missiles and Rockets:

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nblies is their light weight—about
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h Cornelius compressor assemblies
considered to be ample for all com-
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BILE TEST SET—A new, completely
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y out fast, accurate adjustments and
surements on CEC's 5-752 Magnetic-
e Recorder/Reproducer. Such oper-
ns as frequency response measure-
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netic-heat record and bias current
amplifier input/output levels, cali-
ion of FM record amplifiers, set-up
DM recording mode, and equaliza-
tests of analog reproduce ampli-
are all accomplished with the new

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IATURE MOTOR. The Electro Prod-
Division of Western Gear Corp. has
ew miniature motor, Model 2PP1,
d at 1/100 HP at 11,000 RPM. It
been qualified to MIL-M-8609 speci-
ion. The 26.5 volt D. C. motor is
in diameter, 1.9" long and weighs
oz. Life is 500 hours without change
rushes.

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TEMPERATURE SENSOR. Available immediately from stock in tape-on or self-adhering models, Minco's Thermal-Ribbon by Minco Products, Inc. provides sensing of temperature for monitoring or control. Measuring 3/8 inch by 2 inches by .020 in., the Thermal-Ribbon is thin and flexible for use on flat, curved, or irregular surfaces. It can also be built into equipment. Resistance is 676 ohms per degree C. at 25°C. Thermal time constant is as small at 1/2 second—depending on installation.

Circle No. 237 on Subscriber Service Card.

TRANSISTORS. Silicon PNP transistors for 1 to 4 megacycle operation in severe environments have been established in production at Sperry Semiconductor Division, Sperry Rand Corp. Four new alloy junction transistors incorporate "micro-control," a new Sperry design feature that holds input resistance in all units to a uniform value. Selection problems are reduced by the uniform 35-ohm value, which is one-third the input resistance previously realized in megacycle transistors. Collector voltages of the new units have been made up to 3½ times higher to extend use of these transistors to gate circuits, amplifiers, regulators and convertors for missiles and controls where higher collector voltage and gain are desired.

Circle No. 232 on Subscriber Service Card.

MOTOR. The Instrument Div. of American Electronics, Inc. has a Size 11 Stepper Motor, Model PM112A3, a permanent magnet rotor bi-directional stepper motor for precision rotary motion without reciprocating parts. Stepping rate is 90 pulses-per-second in random pulse direction. The unit is basically bi-directional, furnishing the desired degree of rotor step for each pulse. The Stepper Motor Model PM-112a3 can be supplied with internal logic circuitry—either mechanical or solid state, for adoptation to existing systems and circuitry.

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MISSILE LITERATURE

BULLETINS. Miles Samuelson, Inc. has recently established a Technical Information Exchange and has issued a series of bulletins covering various aspects of military contract work, principally in the publications field. The first two bulletins, "The Facilities Brochure" and "Space Age Art," are available. A third, "The Proposal," will be available shortly.

Circle No. 200 on Subscriber Service Card.

SERVO AMPLIFIER. Magnetic Amplifiers, Inc. has made available a four-page brochure describing the company's new line of Transi-Mag Servo Amplifiers with power ratings to 16 Watts. Complete specifications data, circuit theory and applications for missile use are provided.

Circle No. 201 on Subscriber Service Card.

ANALOG-TO-DIGITAL CONVERTER DATA. A four-page illustrated brochure providing design information on a new device for shaft analog-to-digital conversion is offered by Data Instruments Div. of Telecomputing Corp. The brochure shows typical pulse output waveforms and is illustrated with photographs and drawings of the equipment and functions. Applications of the device are described in terms of specific equipment requiring measurement of shaft position and rotation direction.

Circle No. 202 on Subscriber Service Card.

VIBRATION TESTING SYSTEMS. Three bulletins are now available for use by aviation, missile, and rocket design and test engineers engaged in precise vibration analysis. These brochures, offered by MB Manufacturing Co., New Haven, Conn., give detailed specifications of each of the components of the system as well as system performance. For convenience, the company's most widely used line of vibration testing systems has been divided into three categories, 1200 to 2500 lbs., 1750 to 5000, and 7000 to 25,000 lbs., based upon the total pounds of output force available.

Circle No. 203 on Subscriber Service Card.

FLOW TRANSDUCER. The Ramapo Instrument Co., Inc., announces the publication of a new four-page brochure on the Mark V Flow Transducer. The Mark V, specificially designed for the measurement of single or bidirectional flow, is fully covered. Such details as range, pressure, temperature, frequency response, line sizes and materials are covered in a General Specifications section; the Electrical Information section covers input, output, resistance.

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WALK-IN CHAMBER. A six-page b chure is offered by Conrad, Inc., sh ing walk-in environmental chambers temperature, altitude, and humidity. brochure describes complete missile t facilities and components testing un It also lists field application offices.

Circle No. 205 on Subscriber Service C

SIDE MOUNTED CONNECTORS. illustrated bulletin giving specificatio outline dimensions and general inform tion on new Series "G" miniature c nectors, is available from Electro Sales Div. DeJUR-AMSCO Corp. Th unusually small, rectangular connect having the added feature of space-s ing side mounting are available in 2, and 4 contact arrangements.

Circle No. 206 on Subscriber Service C

POLARIZED RELAYS. A new 8-page b letin recently released by Barber-C man Co., offers a series control syst suggestions, and describes some of many possible applications of the pol ized relay. Suggested uses for the co pany's Micropositioner relay are list under the headings: General Contr Instrumentation, Servomechanisms a Transistor Circuits. All applications well illustrated with helpful wiring d grams and photographs.

Circle No. 207 on Subscriber Service Ca

TRANSFORMERS. Minitran Corp.'s est catalog describes transformers a related magnetic components design and manufactured by the company electronic instrumentation applicatio Transformers covered range in weig from 0.45 to 0.5 lbs.

Circle No. 208 on Subscriber Service Ca

MOTORS. Electric Indicator Co., In manufacturers of instrument-type mot and generators, has just published completely-revised edition of their ca log #El-4 on Elinco synchronous Moto It includes detailed data on over 2 synchronous motor designs, many them only recently developed, and off technical information on the theory a application of all types of synchrono motors.

Circle No. 209 on Subscriber Service Ca

SERVO VALVES. Catalog 220, just pu lished by Moog Valve Co. Inc., describ the firm's line of flow-control ser valves for use in a wide range of missi and nuclear applications. Detailed i formation on valves in this series is a companied by curves on normal fl gain tolerance, load flow-pressure ch acteristics, typical frequency respon

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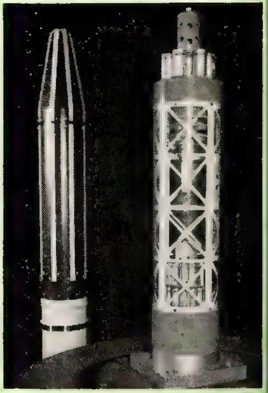
The actual conditions of space flight were computed in a synthesized program, and, using Ling Electronic power generators and advanced techniques, space flight conditions were duplicated in the laboratory!

The ability to develop complex test equipment for new and challenging areas such as this is one of the reasons Ling is recognized as a leader in high power electronics.

Because of the conditions encountered in the flight to space, a random wave program was the only vibration test considered realistic enough for the Explorers. Tests at JPL included random noise band limited to 20-1500 cps with an amplitude as great as 25 G rms perpendicular to the thrust axis. Shown on the shaker table is an Explorer instrumentation package.



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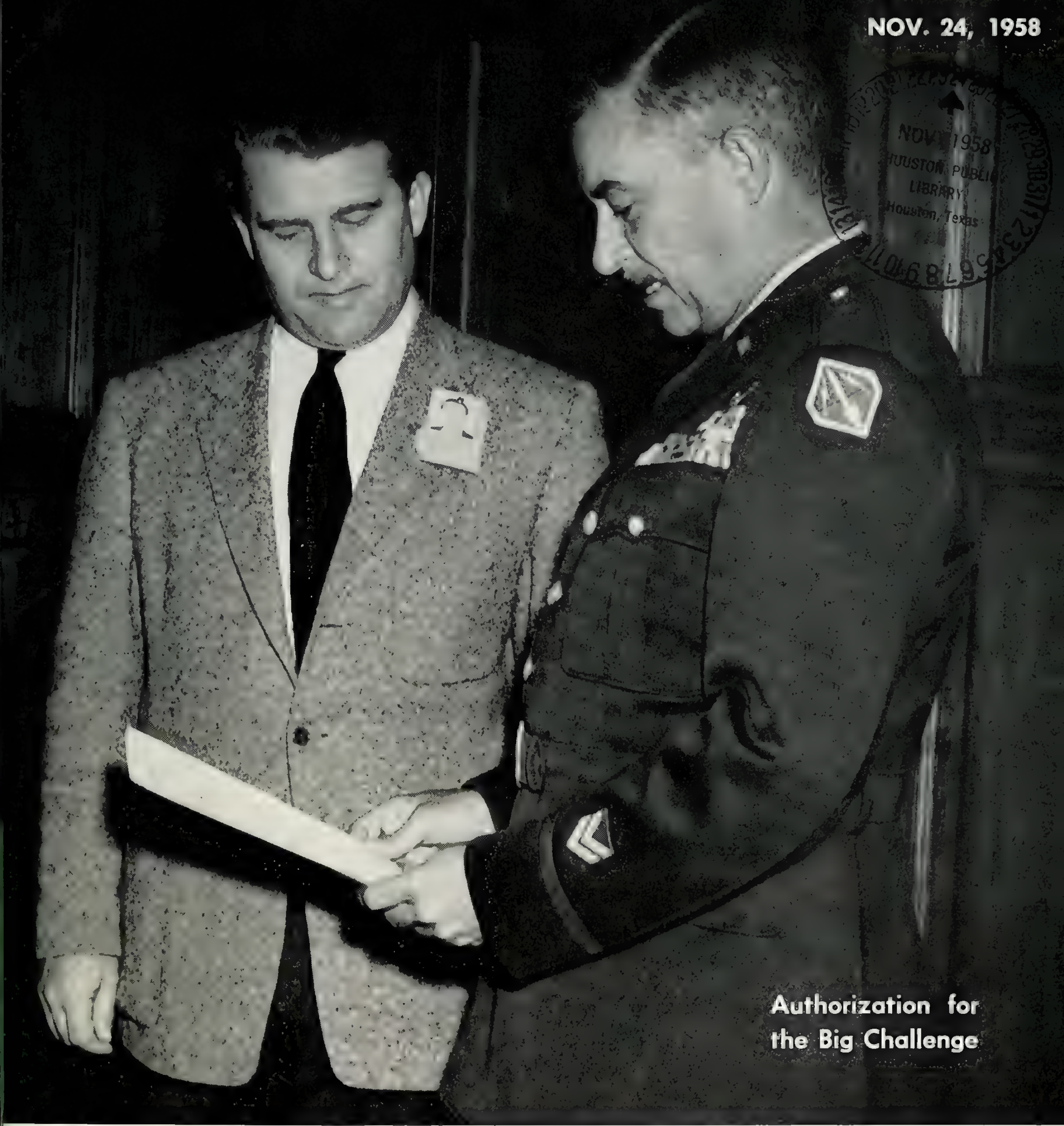

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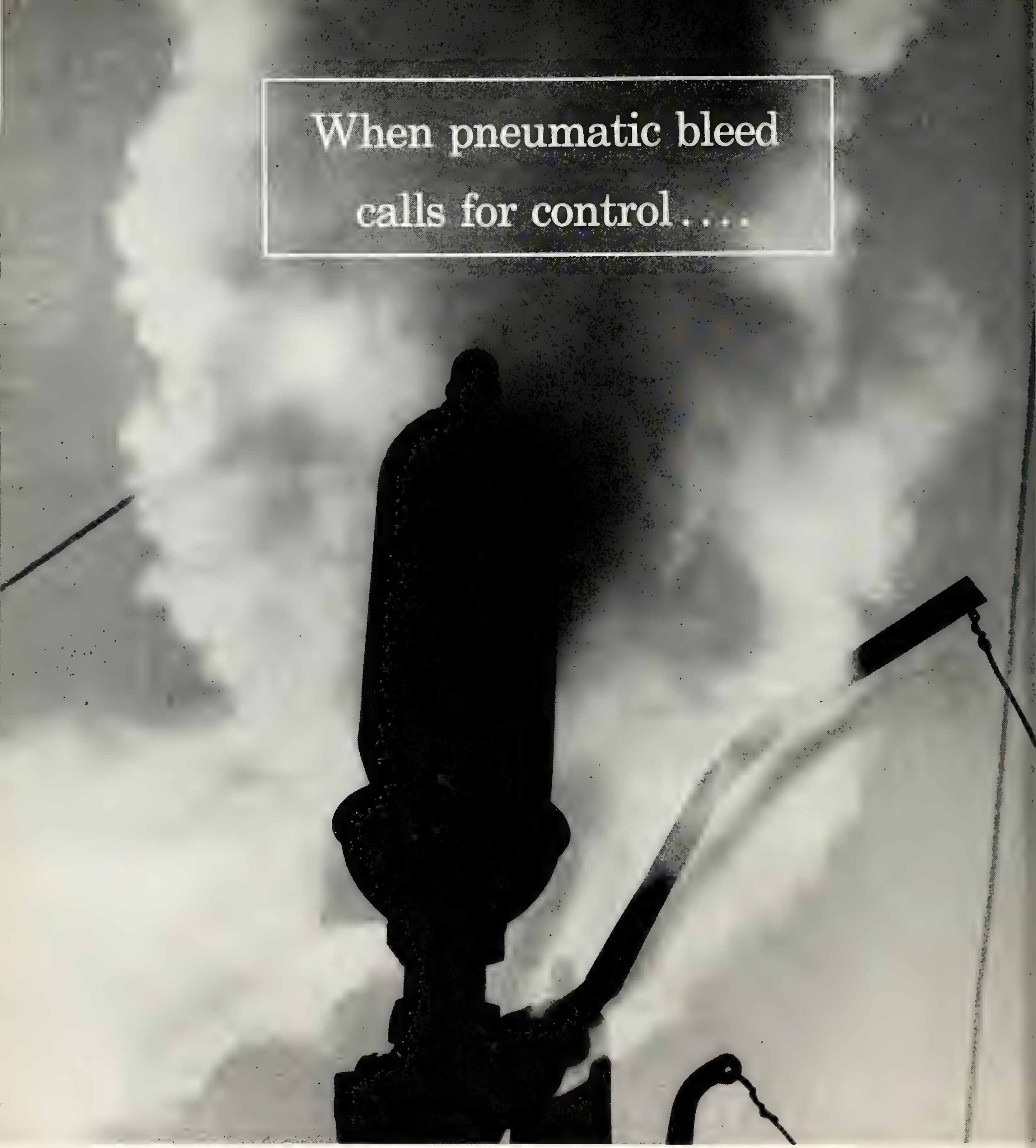

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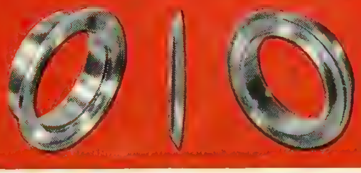
Light Duty	—300 to + 750	1500 psig
Medium Duty	—300 to +1250	3300 psig
Heavy Duty	—300 to +2000	6000 psig



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COVER: *Dr. Wernher von Braun and Maj. Gen. John B. Medaris. With Air Force lunar probes past, Army team readies for possible December 5 Juno II firing which will by-pass, rather than orbit the lunar body. (Story on p. 25.)*

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missiles and rockets Vol. 4, No. 21, Nov. 24, 1958

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in this issue

NOV. 24 HEADLINES

U.S. to make Mars Probe about March 1
Vehicle would rendezvous with planet eight months later. Venus launch date would be in late January, 1960 ....**13**

Interplanetary Travel Poses New Medical Problems
Man can survive for at least two weeks, but beyond that many "unknown" areas must be solved **28**

Soviets Release *Sputnik II* Details **38**

DOD Looking Toward Cutting Out Missiles
Decision due soon on *Thor-Jupiter.* Other systems may fall under the economy axe **41**

ASTRONAUTICS ENGINEERING

***Dyna-Soar* Brings Out New Martin Team Concept**
Prime-subcontractor relations change as Space Flight Division assembles top personnel in design competition stage with Boeing ..**16**

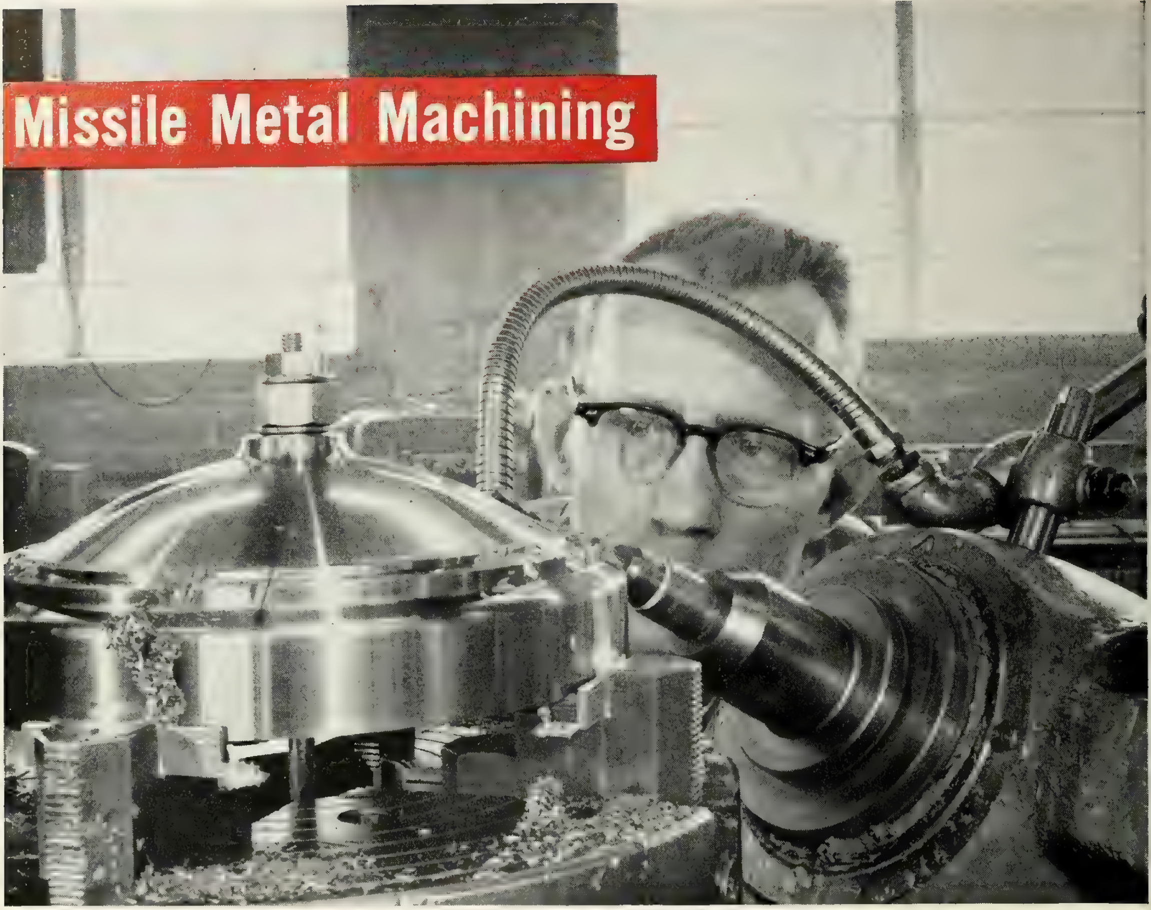
'Unsophisticated' Juno II May Orbit Sun
'Souped-Up' Jupiter will fire all four stages in sequence to reach lunar vicinity in 34 hours after lift-off **25**

MISSILE ELECTRONICS

Fusion 'Pinch Effect' Is Termed Unpromising
Controlled thermonuclear power can be achieved by revolutionary microwave heat containment processes **32**

DEPARTMENTS

In My Opinion 7
Washington Countdown 9
Industry Countdown 11
When and Where 38
Contract Awards 41
Propulsion Engineering 42



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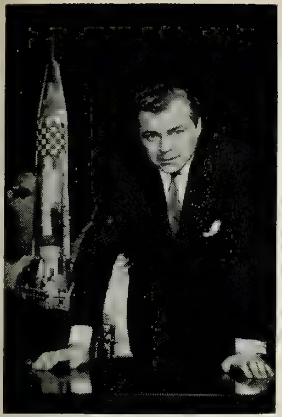


In My Opinion . . .

. . . there's no doubt the missile and rocket industry is here to stay and that it will continue to grow. As a matter of fact, it now represents one seventh of our total defense expenditure. Yet, some conservatives say the missile industry is nothing but a fading myth! In the past two years—since missilery has become a major part of the defense expenditure pattern of this country—there's been a lot of bitter and probably needless infighting over that one single word "industry."

Understandably, perhaps, the tendency to call missilery an "industry" has brought violent argument from those who have felt that their previous experience and service in aircraft work made this term a misnomer, and somehow put them outside the pale of a new field.

Equally bitter have been many inspired proponents of the new art—some of them manufacturers who never had any interest in aircraft, but who certainly have a large stake in missiles.

The "missile industry"—just like the "aircraft industry"—doesn't control its raw materials or subcontractors; it calls on many other industries to serve it and supply materials and skill. What's more, who really cares very much what it is called, or who does the work?

The fact remains that missilery is a new business—and that it is a big business. A $6.5 billion business, to be exact.

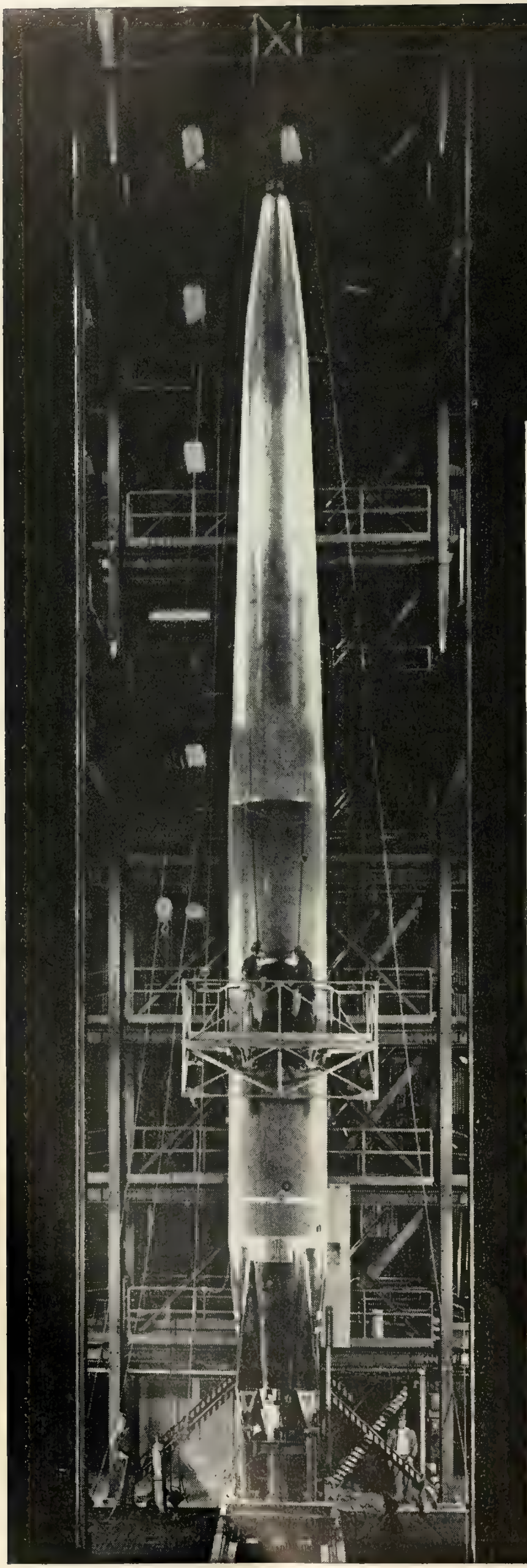
It is a new market for old skills and old products. And a brand new market for a lot of brand new skills and new products. It is making work—and money—for a lot of service groups, such as the construction industry, watchmakers, piano builders, chemical companies, and others, which must come into the missile picture to keep the birds flying. It is a brand new employment market for something like 400,000 people. (See m/r, Nov. 10, p. 11.)

And out of it will come many things other than the missiles themselves. Out of it will come new scientific worlds to conquer, new engineering frontiers to attack. And more prosaic things that will contribute much to everyday living.

Transistorization, miniaturization, new metals and materials, new uses for standard things—these cannot but contribute to human comfort and ability, beyond the immediate uses in missiles and engines of warfare. Many refinements of the present-day motor cars and airplanes are ready examples of what can be developed out of what started out to be war machines only.

So it doesn't matter very much if we call this new field a new industry or a new business or what. And it gets us absolutely nowhere to argue about who has a right to be in it. This is everybody's business.

Erik Bergaust



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MISSILE DEVELOPMENT DIVISION

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washington countdown

Navy takes comfort . . . that the Lockheed *Polaris* was not specifically mentioned in Secretary McElroy's discussion of down-grading importance of land-based IRBM's. This adds steam to Navy's argument "to get the missiles to sea" rather than basing retaliatory hardware in continental U.S. which the Navy says puts bull's eye right on this country.

Russian submarines . . . are operating off Cape Canaveral despite a statement to the contrary made by Maj. Gen. Donald Yates. Can reported instances of jamming of missile telemetering channels be explained? Or, the case of a diver retrieving a missile 14 miles away in 100 ft. of water, having seen a submarine and the air hose of another diver? The other diver left his boot mark on the missile's (probably a *Redstone*) tail assembly, and whereabouts of some parts of this particular missile apparently are in doubt.

Navy's top priority . . . interest in underseas exploration has a boost from Sen. Henry M. Jackson who termed the vast underseas spaces as a "full new area of development which has not been tapped." He said the Russians are far ahead in this field. Jackson also advocated that NATO nations cooperate to send up a satellite for peaceful outer space research by 1960.

Weapon systems management . . . probe will begin this month by Armed Services Subcommittee. "High costs" of weapons and "team approach" will be explored.

Peace is the word . . . when it comes to space. Senate majority leader Lyndon Johnson said so at a San Antonio meeting on space medicine. ARPA Director Roy Johnson said it in New York and Ambassador Lodge said it at the United Nations. Johnson said the U.S. "has no military offensive objectives in space," but must develop a defensive posture in space. Lodge introduced a resolution co-sponsored by 19 other countries for development of a peaceful outer space policy. Russians countered with demand that foreign bases be relinquished as part of price for ban on use of space for military purposes. Johnson, speaking before the UN, said this nation has no differences "within our government, between our parties or among our people," on the goal of dedicating outer space to peaceful purposes.

Germany and Italy . . . have held informal talks on mutual cooperation in the field of missiles for non-military use, possibly for research or as future transport carriers. Since the Germans are still not permitted to conduct any work on military missiles, this might be a device to lay basic groundwork so that Germany may get back into the military missile field as quickly as possible when they are officially authorized to do so.

Rough trail ahead for Texans . . . Sam Rayburn and Lyndon Johnson. The Senate and House majority leaders will have their hands full riding herd on fellow Democrats when Congress convenes in January. Freer-spending members will force them to find a safety valve somewhere between expediency and caution. Leaders will have to tread narrow path to avoid an insurrection on one hand and responsibility for too much spending on the other. An old, an unhappy position, but new for Rayburn and Johnson.

First standing committees . . . will be named in both House and Senate to deal with matters of space and science. In the past session, House had a select committee and the Senate a special committee. New committees assume jurisdiction no other standing committee has—joint responsibility in both military and civilian areas. Astronautics committees will cover both. House committee will have 25 members, Senate committee will have 15. Johnson will be chairman of Senate group. Good bet for House chairman is Paul J. Kilday of Texas or possibly Overton Brooks of Louisiana. Committee's jurisdiction covers complete field of astronautics, standardization, NASA and other matters including science scholarships. Members will be appointed by committees with division in keeping with ratio of the parties in the House.

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industry countdown

Chemicals for missiles . . .

are expected to corner a large portion of the defense market in the forthcoming months. Reliable forecasts of estimated expenditures for missile chemicals and related products (fuels, oxidizers, lubricants, sealants and plastic coatings) indicate a climb from $700,000 in fiscal 1959 to $1 billion in fiscal 1961.

Navy strategic dispersal policy . . .

of ship construction for achieving faster delivery of missile carriers has been advanced by the latest award of $182.5 million to four firms for construction of seven frigates. All contracts were awarded on a fixed price basis, as a result of competitive negotiations, to six yards submitting the lowest proposals from a total of eight invited firms. Bath Iron Works will build three of the frigates; New York Shipbuilding Corp., two; Dodd Shipyards Corp., and Puget Sound Bridge & Dredging Co., one each.

ARPA's recent research award . . .

of about $8 million to a number of chemical firms for long range studies of new chemicals for solid rocket propellants (m/r, Nov. 10, p. 11) has generated some bitterness among longtime rocket firms. The awards have been described by these companies as "neither intelligent nor fair" they have put their own resources and funds into similar research. For example, Olin Mathieson said it has spent about $2 million and utilized some 50 engineers and scientists for advanced studies on solid propellant combinations.

Tow trucks in space . . .

has been forecast by Norman V. Petersen of Lockheed Aircraft Corp. as a necessity for the not too distant future. He predicted that space traffic will be so heavy that it will be necessary to have fleets of rocket-powered tow trucks for rescue of space travelers in flights between earth and the planets.

Architects of space . . .

will be an appropriate title for Daniel, Mann, Johnson, & Mendenhall, Los Angeles architectural and engineering firm, when construction dollars for missile bases are summed up at the end of fiscal 1959. The firm was in third place in 1957, having completed projects with a construction value in excess of $150 million.

Ballistic missile facilities . . .

designed by DMJM include the Santa Susana hot test acceptance facility for North American; *Atlas* test facilities at Cape Canaveral and Sycamore Canyon: ICBM/IRBM training facilities throughout the U.S.; and *Thor* testing and launching facilities at Vandenberg AFB. The firm is proposing to design the Air Force's *Titan* facilities.

Underground missile factories . . .

are receiving more attention from military and industrial planners. Convair's next missile plant reportedly will be built underground as a precaution against nuclear attack. Moorehead Patterson, head of American Machine and Foundry has long advocated underground plant construction recently proposed using Green Mountain at Huntsville, Ala. for such a plant. The Germans in World War II found that plants underground were the only solution to continued production of the *V-2* rocket.

Army is evaluating . . .

Aerojet-General's Aerotrac (Target Recognition Artillery Concept) designed to fit into the fluid battlefield planning. The system would employ target "illumination" for attacking infra-red guided missiles. Concept is similar to the Project *Mauler* program now under study by ABMA, Martin-Orlando and Convair. Briefings by Aerojet were recently held with the Army Rocket & Guided Missile Agency (ARGMA) and the Continental Army Command.

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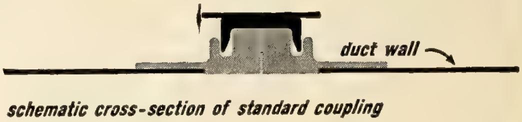
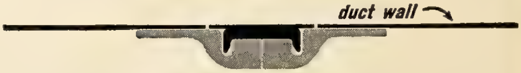


schematic cross-section of standard coupling



schematic cross-section of flush coupling

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NOVEMBER 24, 1958
VOL. 4, NO. 21

missiles and rockets
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March 1 May Be Mars Probe Date

Heliocentric force field of sun would be used rather than complex guidance so that probe would rendezvous with planet eight months later. Probable Venus launch date is January 1960, using present 'on the shelf' hardware.

by William O. Miller

WASHINGTON—The United States will make the first attempt to launch a space probe to the vicinity of Mars late in February or early March, if such an attempt is to be made any time within the next year.

While no official go-ahead has been announced, a National Space and Aeronautics Administration scientist agrees that a launch date about March 1 "could be right on the button," for a rendezvous with the planet a little over eight months later.

Two factors make such an attempt a strong probability: first, the heliocentric movement of the planets Mars and Venus in reference to the earth will make the effort feasible; and second, NASA scientists say that both the Air Force and the Army now have on the shelf the launching vehicles which, with boosters, could provide the escape velocity for either a Mars or Venus probe.

• **Minimum energy**—this first attempt, by necessity, will employ a minimum energy ellipse. Present hardware, with boosters, can supply the 25,000 mph required to escape the earth's gravitational field for a probe of Venus, or the 25,900 mph required for Mars, according to Newell Sanders, NASA assistant director of advanced technology. The big problems, he said, are communications and guidance. The simplest way, but longest time-wise, is to utilize the heliocentric force field of the sun so that the vehicle's path flight is cotangential to the orbit of the planet. This is more easily accomplished when the planets are on opposite sides of the sun, but in a straight line. This occurs only on certain dates. The next time Mars will be in this superior conjunction with the earth will be October 30, 1959. It will not occur again until December 14, 1961.

Thrust for escape from the earth would be used up a few minutes after launch. On its 350-million mile trip it would coast most of the way, circle Mars and continue in an elliptical orbit to return to the vicinity of the earth.

Dr. Newell said the time for such a trip to Mars would take about 247 days. This would place the launch date some time during late February or early March.

• **Venus too?**—Such an ellipse could be utilized in probing the vicinity of Venus, taking into consideration the dates when Venus is in superior conjunction. As Venus circles the sun in an orbit between the earth and the sun (Mars' orbit is beyond the earth's) the flight time is only about 151 days.

Venus was in superior conjunction with the earth on November 11. The next date will be June 22, 1960. Considering the flight time required, a probable launch date for a Venus probe would be in the latter part of January 1960, little more than a year from now.

• **Moon probe first?**—The Advanced Research Projects Agency, before NASA came into existence, asked the military to come up with plans for Mars and Venus probes. In the excitement over the lunar probes, sight has been lost of these projects. The Air Force, however, has been agitating for revival of the projects.

Another NASA scientist admitted he was part of a team presently working on the planetary probes. Although they are separate projects, for political reasons and in the interest of worldwide public relations, the probes could be held up until a successful probe of the moon has been accomplished.

• **Have vehicles**—The Air Force presently has two *Thor*s on the shelf, ordered by ARPA. The Army has *Jupiter*s which also could be used.

The thrust for the moon probe is slightly under 24,000 mph. With a little boost this could be raised to the 25,000 mph for a Venus probe or the 25,900 mph for the Mars shoot.

The payload of the last Air Force moon probe was about 85 pounds. By removing the retro rocket and reducing the payload by about one-half, the extra speed required undoubtedly could be attained.

Thrust is not a problem. The big question is instrumentation, guidance and communication. NASA scientists point out that when guidance and control is attained which will permit correction in flight, probes of Mars and other planets could be carried out at almost any time, but especially when they are nearest the earth (inferior conjunction) rather than at the greatest distance, as in the case of superior conjunction.

• **Communications**—Even with the vehicle coasting most of the way, the distance and time of flight pose numerous communications problems.

Since path loss over the distance to Mars has been estimated at about 263 db., a transmitting frequency of more than 2000 mc is indicated. This would have a receiver noise figure of 6 db. and a band width of no more than 1 kc. because of the great range and the necessity for keeping the receiver noise figure as low as possible.

Somewhat sophisticated circuitry will be required to handle the doppler shift as the radial velocity between the transmitter and receiver varies. A transmitter with about 10 watts of power into the antenna would seem necessary although this might be less if it is worked into the huge Jodrell bank radio telescope in England.

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IS THE ROCKET ENGINE MAN'S ONLY WAY TO OUTER SPACE?

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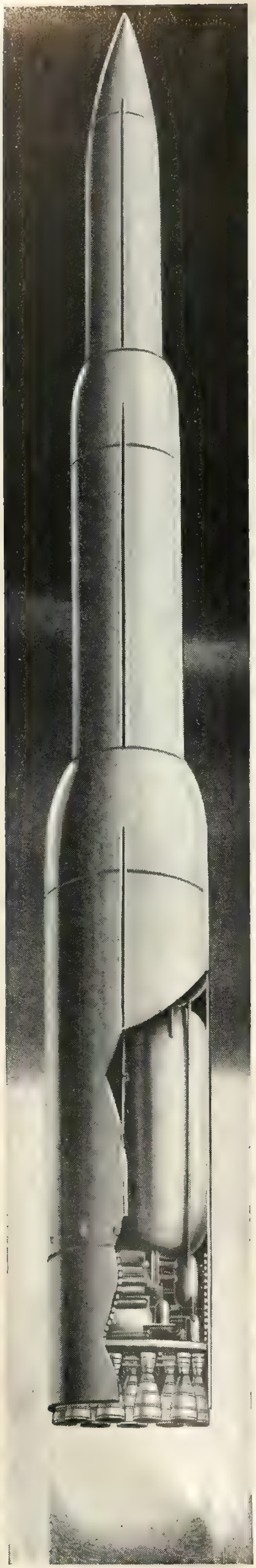
The only power that can put him there today is the large rocket engine. No matter how far and how fast space travel develops, these high-thrust engines provide one basic essential—the sheer brute force that can lift a payload from the surface of the planet to the airless void outside.

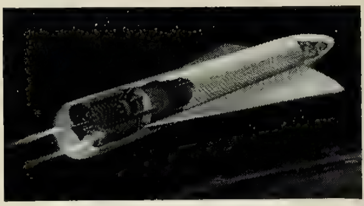
Endurance for vast distances

Once space is reached, a wealth of intriguing possibilities beckons. Entirely new aspects of propulsion are being developed to maneuver ships between the moving gravitational fields of Earth's neighbours in the solar system.



PACKHORSE OF SPACE. *Only means to put stores or people out beyond atmosphere is the big, high-thrust rocket.*

One advanced propulsion system that may be built soon is an ion rocket. This ultra-high-specific-impulse power plant provides low thrust for extended periods.



OUTWARD BOUND, *man's robot reporter heads off to a rendezvous with planet Mars.*

An endurance of months, or even years, is possible. Mounted in a suitable unmanned vehicle, such an interplanetary "private eye" would make the cislunar region seem like our own front yard. It could be sent off to reconnoiter the mysteries of Mars, Venus, or the Asteroid Belt.

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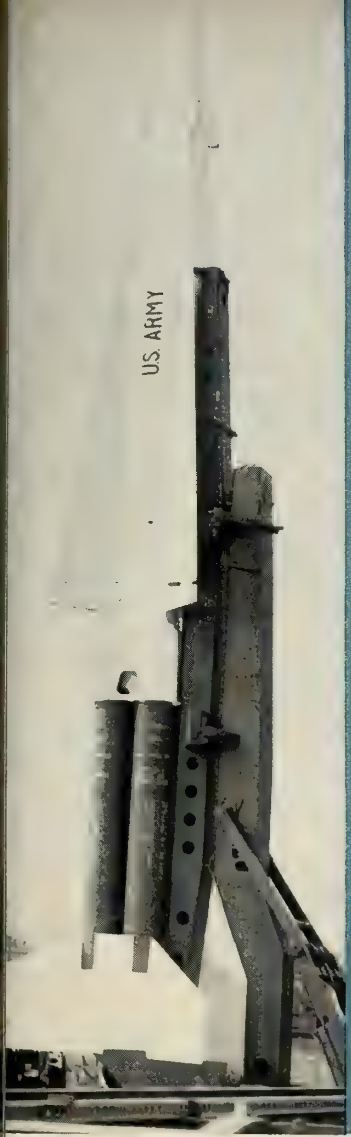

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Dyna-Soar Brings Out New Martin Team Idea

Prime-subcontractor relations change as Space Flight Division assembles top personnel in design competition stage

by Donald E. Perry

BALTIMORE—These are crucial days for a new concept in space project management that is decidely odd from an industrial standpoint—but could well be the "writing on the wall" for management to revise its approach in dealing with future complex space systems.

It is the Company Team Concept as opposed to the Prime-Subcontractor System. Eight months from now—about July 1—and perhaps sooner depending on priority assigned, the National Aeronautics and Space Administration and the Air Force will make a decision. The outcome will not necessarily make or break the Company Team Concept because it is in the ticklish area of design competition. And as all industry should know, the best design should win the competition, although many firms will argue this point at the drop of a contract.

But the stakes in this competition are high and worth all the effort, even though money to be realized through production is a secondary factor. The primary factor is prestige and a chance to build company technical capability at government expense. The battle is of more than routine interest because it pits two industrial giants—the Martin Company and the Boeing Airplane Company—against each other.

The competition is for the romanticized boost-glide *Dyna-Soar,* either the last of a long line of airplanes or the first truly space ship.

• R&D contract—Outcome will be an R&D cost-plus fixed fee contract. But the management method of bringing *Dyna-Soar* to reality brings the occupied airplane vs. the automated vehicle approach to the forefront again.

But what is the Martin Company's approach to *Dyna-Soar?* You're visibly impressed from the moment you park your car in a special lot at the Middle River, Md., facility. As you enter a special door marked "Space Flight Division," you feel you're separated from the Martin Company. That's the intended impression. For it is a separate, autonomous division, although it will not manufacture hardware.

In the Space Flight Division—unless you ask—you can't find out who signs whose pay check, because side-by-side are individuals working from Martin and Bell Aircraft. It gets further "chummy" with daily representatives from Bendix Aircraft Corp., Minneapolis-Honeywell Regulator Co., Goodyear Aircraft, and American Machine and Foundry Co., other *Dyna-Soar* team companies.

George S. Trimble, Jr., Martin vice-president and general manager of the division, and Roy J. Sandstrom, Bell vice-president and assistant general manager of the division, occupy the same office. They term the situation as "a family marching down the same road." And it has to be that way for Air Force does not want to deal with a multiplicity of companies, only one—in this case—Martin.

But the chiefs march in unison with the Indians. For if the *Dyna-Soar* team members get off the path, a management advisory board steps in. It is not staffed by representatives of the presidents of the six member companies, but by the presidents themselves. This is conducive for the best efforts.

• Unity on team—"We have decided unity," comments Trimble, "because at the beginning we laid some good ground rules." The rules make the Team Concept odd. First, the companies are not really subcontractors to Martin. Each firm has a copy of the work statements of all the others. Each knows how much money the other is getting, and everyone agrees in the sharing before it's made. So far there is little to share—about $5 million has been programmed. As one example, team thinking is that Bell, a pioneer investigator in the boost-glide field, should get a larger slice at this stage of the competition. Reason: previous advanced study efforts.

This is in strange contrast to the general prime-sub relationship, where the prime can tell his subs to keep their mouths shut. However, Martin wants each company to be in a position to tell the whole *Dyna-Soar* story, but it still will retain total systems management responsibility to the Air Force.

Martin which gained managerial know-how in team efforts by being one of the pioneers of the weapons system approach many years ago, admits that its *Dyna-Soar* management concept was "a shock to some of the team members at first," but all apparently have adjusted to this unusual way of doing business.

"Togetherness" may be an appropriate word in light of this philosophy of the "captain" treating all alike. Most assuredly it will have to be used more extensively in complex space programs beyond the capabilities of one single company.

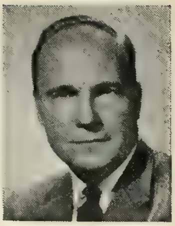
Dyna-Soar, visioned in Eugen Sanger's 1935 proposal, ultimately will mean men in space performing military objectives. Whether they get there under the traditional aircraft method of development—man flying higher and faster—or whether an automated

(Continued on page 18)

George S. Trimble, Jr.—Martin vice-president and Space Flight Division general manager. Holder of design patent for B-51; Martin vice-president for Advanced Design and Engineering; B.S. MIT; Tau Beta Pi; member NASA Committee for Aerodynamics, DOD Technical Advisory Panel for Aerodynamics.

Roy J. Sandstrom—Bell vice-president and Space Flight Division assistant general manager. Holder of design patent for *X-2;* Bell vice-president of engineering and general manager of Weapons System Division; B.S. University of Michigan; Tau Beta Pi, IAS, ARS.

Trimble


Sandstrom

William L. Hadley—Director of Reliability and Safety. Hadley was Chief, Reliability Control Section, Bell Aircraft Corporation; B.A. degree at University of Buffalo; member, American Rocket Society; will have charge of escape system in the *Dyna-Soar* boost glide vehicle.

Norris Elliott Felt, Jr.—Program Manager. Felt was operations manager for *Vanguard;* B.S., University of Maryland; M.S. Georgia Institute of Technology; Tau Beta Pi, Phi Kappa Phi, Eta Kappa Nu; member, ARS, AIEE, president of Maryland ARS Chapter.

Hadley

Felt

Hans Multhopp—System Technical Director. Multhopp was research scientist for German Air Ministry, chief of Aero & Advanced Design—Focke Wolf; principal scientist for Martin Company; University of Gottengen graduate; member, Lilienthal Gessellschaft, IAS, Deutsche Akademic for Luftfahrtforschung.

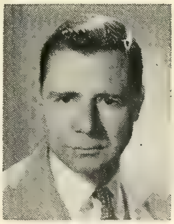
John DeNike—Director of Configuration Design. DeNike was project engineer for Martin Company's Advanced Design; B.S. New York State College for Teachers, Rensselaer Polytechnic Institute, Tau Beta Pi, Sigma Xi; member, ARS, IAS.

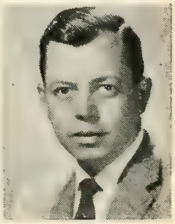
Multhopp

DeNike

Wallace A. Helmuth—Director, Military Operations Analysis. Helmuth was Chief Advanced Design Military Operations Analysis Section for Martin; B.S. New York University, attended Johns Hopkins University; Tau Beta Pi; member, Operations Research Society of America.

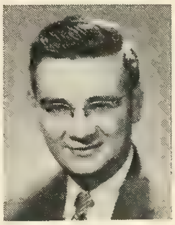
Robert Glen Demaree—Director Crew Factors. Demaree was assistant professor at University of Illinois and Tulane; chief of Performance Branch, Lowry AFB; full-time consultant to Army Air Defense Human Research Unit; B.S., M.A., PhD., University of Illinois; member, American Psychological Assn.

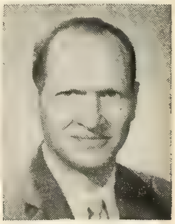

Helmuth


Demaree

Charles J. Koch—Director Systems Dynamics and Controls. Koch was director of research and development and principal engineer for Martin; B.S. Case Institute of Technology; Tau Beta Pi, Sigma Xi; member of the Institute for the Aeronautical Sciences.

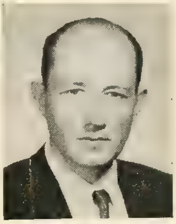
Donald W. Chrisman—Director Electronics and Electrical. Chrisman was Engineering Field Test Supervisor, principal staff engineer, and chief engineer electronic equipment design for Martin; B.S. Purdue University; Tau Beta Pi, Eta Kappa Nu; senior member of Institute of Radio Engineers.


Koch

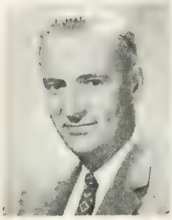

Chrisman

Dr. Peter Friedrich Jordan—Director Structures. Jordan was a German Air Ministry Group Leader; principal scientific officer, Royal Aircraft Establishment, Farnborough; chief dynamics engineer for Martin; University of Gottingen, University of Breslau, Dr. rerun naturarum.

Dr. Julius Friedrich Vandrey—Director Aero and Space Physics. Vandrey was Group Leader in German Air Ministry; scientific advisor to Admiralty Research Lab, Teddington, England; principal engineer for Martin; Dr. rerun naturarum (Magna Cum Laude), University of Gottingen, Technical University of Hanover; member, Gesellschaft Fur Angewandt Mathematick & Mechanik, IAS.


Jordan

Vandrey



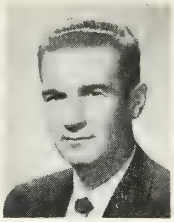
Guy

Marstiller

Walter G. Guy—Director Plans and Programs. Guy was Project Engineer, Manufacturing Manager and Operations Manager for The Martin Company. He is a graduate of the Academy of Aeronautics in New York and holds membership in many U.S. professional and technical societies.

James K. Marstiller—Contract Director, Bell Aircraft Sub-Contract. Marstiller was chief project test engineer for Chance Vought; deputy chief for B-36, YB-60 and B-58 projects; Bombardment Branch, Air Materiel Command; S.M., MIT; technical member of Institute of the Aeronautical Sciences.

Gravenhorst

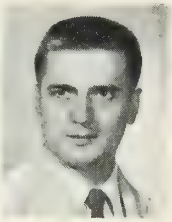


Hooker

Gordon P. Gravenhorst—Contractor Director—AMF Sub-Contract. Gravenhorst was a project engineer and the P5M Operations Manager for Martin; M.E. from Stevens Institute of Technology; member of Institute of Aeronautical Sciences and other technical and professional organizations.

Ross B. Hooker—Director Facilities Department. Hooker was an industrial engineer for Brown & Sharpe Mfg. Co., Conservation Director, Director of Procurement and Facilities, and assistant to vice president for manufacturing of Martin; attended Brant College, Parks Air College.

Schantz

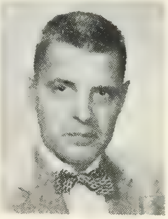


Poletti

Joseph D. Schantz—Contract Director—Bendix and Minneapolis-Honeywell Sub-Contract. Schantz was assistant manager of research, manager of government projects for Farnsworth Television and Radio Corp.; chief electronics engineer for Bell Aircraft; M.S.E. from University of Michigan.

Peter J. Poletti—Director Documentation Department. Poletti was assistant project engineer for *Matador*/B-57; field test manager for *Matador*/*Mace*; B.S. from MIT, MBA from George Washington University; member, Institute of the Aeronautical Sciences.

Singer



Moore

Nathan Singer—Contract Director—Goodyear Sub-Contract. Singer previously was assistant project engineer for Martin; B.S. and M.A.E. from New York University; associate fellow of the Institute of the Aeronautical Sciences; member of American Rocket Society.

Wendell F. Moore—Contract Director—The Martin Company. Moore was chief propulsion engineer on *X-1*, *X-2* series aircraft for Bell; B.S. from Kent State University, attended Indiana Technical College; member, Institute of the Aeronautical Sciences.

(*Continued from page* 16)

machine precedes them as in the case of rocketry developments, may decide the competition between Martin and Boeing.

• **Automated vehicle**—Trimble does not see that the first *Dyna-Soar* vehicle will have a man in it. "He cannot contribute heavily to the first one because there is the question of what man can actually do. I personally do not believe he can do much more than if he were on the ground. When you get into what can he do with military equipment in the vehicle, it's a different matter," he said.

This can be interpreted that Martin is thinking of *Dyna-Soar* as initially an automated rocket development in contrast to Boeing which has already assigned two "pilots" to its project. In other words, the Martin vehicle would be sent up "X" number of times unmanned until reliability is proven.

Then man will enter the picture. These two different approaches could spell a successful vehicle measured in many years of development time rather than several.

But most important will depend on whom is sitting at the NASA—AF design competition decision table—the rocket cycle proponent or the aircraft cycle proponent. Then *Dyna-Soar* will either be the last airplane or the first truly space vehicle.

Rome Research Center and Holloman will give technical advice in cooperation with the Research Vehicles and Advanced Systems section of Wright Air Development Command. Lt. Col. (Russ) Harrington is *Dyna-Soar* project officer.

NASA—whose primary Congressional mandate is the scientific exploration of space—may have a changing role. In the original *Dyna-Soar* proposal, the old NACA was named as a technical consultant for instrumentation. Will it continue to so serve when the Air Force is looking as *Dyna-Soar* essentially as a military requirement?

• **Vital to inventory**—Not just a fish jumping momentarily out of its natural environment, such as the *X-15*, *Dyna-Soar* is considered by the Air Force as a vital addition to its inventory. It will be used in reconnaissance missions at extreme altitudes and bombing missions at closer range.

Sources other than Martin say *Dyna-Soar* with a range of 12,000 to 25,000 miles, will be rocket-boosted to a 100-150 mile altitude and then would glide (assisted by small sustainer rockets) over its target and then on to

(Continued on page 20)

MEMORANDUM ON MISSILE ENGINEERING

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a landing. It is in decided competition with Russia's dynamic soaring vehicle which apparently will use an 820,000 pound thrust engine developed for the T-4 missile.

This alone may dictate approval of the rocket-cycle development rather than the aircraft cycle, and the project conceivably could be given a priority close to anti-missile defense.

But no one can get excited over money potentials. Just like the *X-15* and existing ballistic missiles—which will provide *Dyna-Soar* with vital information—it will not be a quantity production item. Six to a dozen vehicles could be a maxium, but here lies a golden opportunity for participating firms on either the Martin or Boeing team: the chance to develop space technology know-how with a minimum of company sustained fund loss. Prestige thus is an overwhelming factor.

Then too, the qualifications of Bell: if Martin is planning an automated system, they cannot be discounted. Bell is experienced in free-flight and automation as witnessed by the *X-1*, the *X-2*, proportional radio controls for missiles and its completely automatic all-weather landing system. All are musts for an automated *Dyna-Soar* vehicle.

Bendix—which will work on communication systems, telemetry hydraulics, electrical power conversion, cabling, and electrical connectors, can be remembered as teaming with Bell for highly accurate navigation and landing systems. Bendix, too, is known particularly for instrumentation and its integrated instrument cockpit display program and airborne data processing.

Minneapolis-Honeywell came to the limelight with work on the *Titan* inertial guidance system, and this coupled with its low-altitude bombing system used by many current aircraft, is a formidable contender to the Boeing concept.

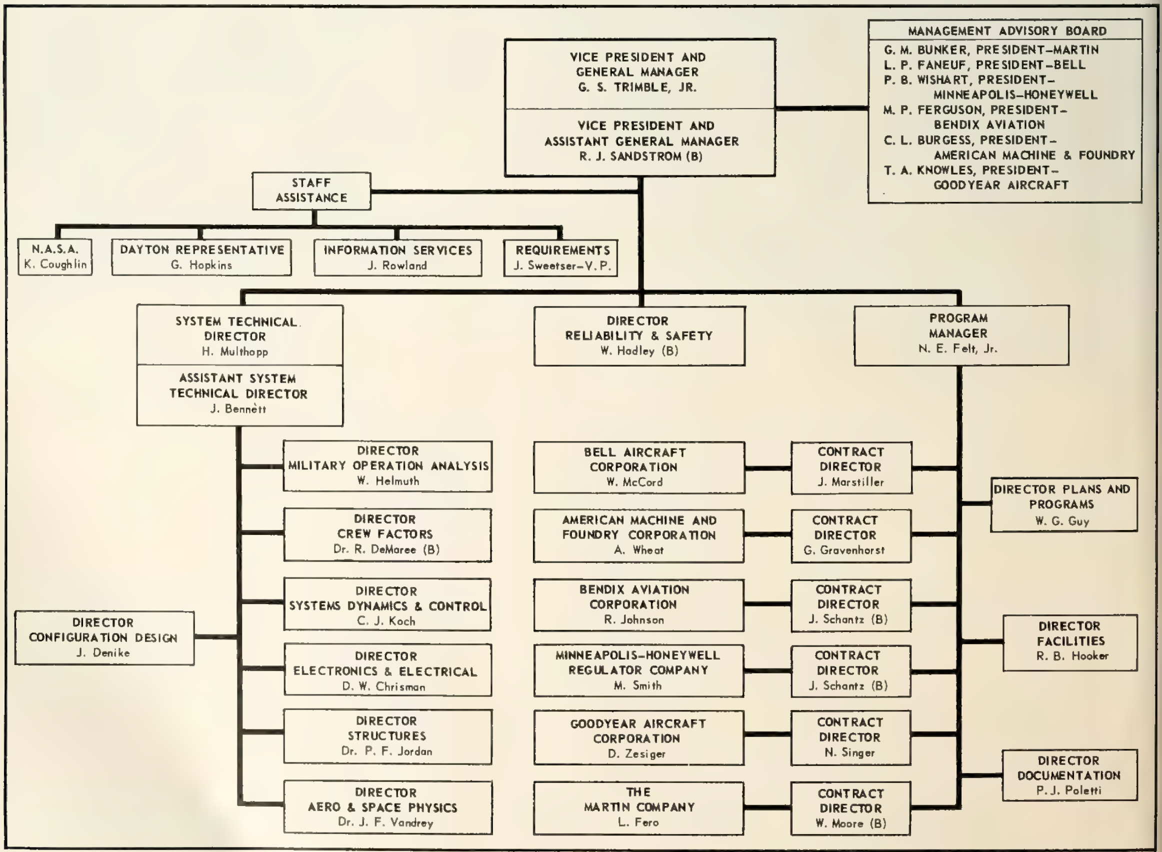
• **On two teams**—Goodyear, by a strange paradox, is on both the Martin and Boeing squads. For Martin, Goodyear will develop the crew escape capsule system, necessary radome materials and high resolution radar. For Boeing it will be guidance.

This should not affect Goodyear's efforts. Air Force is reserving the right to change team members in an effort to come up with the best equipment possible. Team organization, as practiced by Martin, is an effort to reduce the cost, and substitutes can be allowed. But according to Trimble, it is not anticipated that other companies will be needed unless the present ones fail to give Martin the "broadness" needed.

American Machine and Foundry's role in the program will concern the design and manufacture of ground handling and launching equipment. AMF has developed support equipment for the *Talos*, *Bomarc*, *Titan* and *Atlas*. In addition, AMF has done developmental and production work in the radar and ordnance fields.

The Space Flight Division now has 30 Bell representatives and 70 from Martin. It probably will have 80-90 as a maximum during the design competition phase. If Martin gets the R&D contract, total division employment will be 300-400.

Martin Space Flight Division Organization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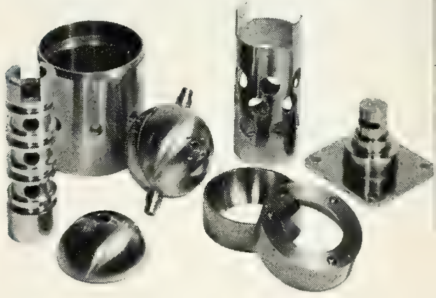

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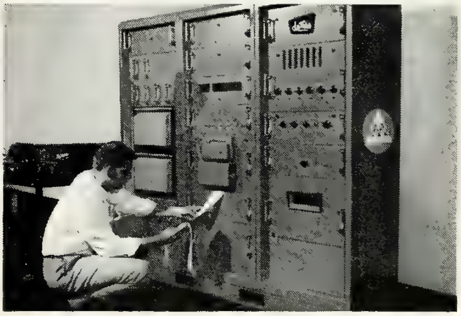

NORTHROP DIVISION

Supersonic USAF T-38, first of Northrop's new N-156 aircraft family, will train space age airmen at minimum cost; is twin-jet safe

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'Unsophisticated' *Juno II* May Orbit Sun

'Souped-up' *Jupiter* will fire all 4 stages in sequence for 220-seconds to reach lunar vicinity in 34 hours after Dec. 5 lift-off

by Norman L. Baker

WASHINGTON—With the spotlight now on the ABMA/JPL team, the Army is taking steps to assure at least one close proximity approach to the moon's surface during the two forthcoming attempts in December and January.

Sophistication of launching systems, when compared with the Air Force *Pioneer* attempts, has been reduced to a minimum in an effort to improve the chances of a successful shot to one-in-two. During the Air Force attempts chances of success were reported at 1-in-25.

The Army technique will employ excess power for an additional margin of velocity and reduction of flight time in addition to ground-monitored guidance for minimizing directional error. The excess velocity is expected to send the payload past the moon into an orbit about the sun. No attempt will be made to orbit the lunar body, therefore eliminating another critical maneuver designed into the *Pioneer* lunar probes.

The *Juno II* launching vehicle will be an extensively modified *Jupiter* IRBM with the standard *Jupiter-C* upper stages. The *Jupiter* first stage will have an elongated RP-1 fuel tank for increasing the rocket's burning time. The upper three stages, in clusters of eleven, three, and one, will be positioned on top of the instrumentation and guidance section, replacing the warhead nose cone.

- **Fire in sequence**—All four stages are expected to be fired in sequence to provide continuous burning, eliminating the coasting phase of the last three stages required with the *Explorer* satellite launchings. First stage will fire for approximately 200 seconds with final stages firing for 6½ seconds each—a total burning time of about 220 seconds.

Burnout velocity will be 24,300 mph or above, placing the payload in the vicinity of the moon in 34 hours. The upper stages will be fired near enough to the earth's surface to present a large buildup in aerodynamic heating. For that reason a special protective cover made with ablative materials will cover the final stages during its trip through the atmosphere.

Juno II will be "aimed" in a direction calculated to either shoot the payload past the moon 10,000 to 50,000 miles from the surface or make an impact with it. Dr. Wernher von Braun stated the chances are one-in-two the payload will miss the moon and wind up in the sun's gravitational field.

- **LEV-3 guidance**—Guidance within the vehicle will probably utilize the proven LEV-3 gyro stable platform for control of roll and yaw with an air-bearing gyro for control of pitch. Deviations from the planned flight path due to internal guidance errors will be corrected by a ground station using a doppler radio link.

The 15-pound instrument payload (10 pounds less than the *Pioneer* payloads) will be comprised mainly of radiation equipment and associated radio system. Lifetime of radio batteries is expected to be reduced due to anticipated short operational period. Major difference in the payload weights of the Army and *Pioneer* probes is the elimination of the retro-rocket and TV scanner systems for the Army attempts. Von Braun stated further that the chance of the payload transmitting useful data is one-in-three.

Continued reception of payload data is anticipated for several hours after the payload passes beyond the moon. The arrival of the payload in the vicinity of the moon will be timed so the moon is directly above the JPL tracking station at Goldstone in the Mojave Desert.

- **Relaxed schedule**—The additional velocity increment plus the elimination of the moon-orbiting maneuvers will provide the Army with a relaxed launching schedule. The moon will be at its closest approach to the earth December 5, the date the launching is expected to be attempted, but the Army lunar probe technique should provide a launching timetable through December 12. Beyond that date, the increasing distance of the moon from the earth, will offset the advantage supplied by the additional velocity and steadily increase the probability of directional error.

Two days, December 8 and 9, of

A MODEL OF THE ARMY'S *Juno II* lunar vehicle is shown in this photograph of NASA officials conferring with Dr. Wernher von Braun at ABMA. The *Juno II*, at right, utilizes the same upper stages as the *Jupiter-C*, a model of which is shown at left. Major difference is use of a *Jupiter* IRBM instead of a *Redstone* as first stage.

ANNOUNCING TW

SPACE TECHNOLOGY LABORATORIES, INC.

Space Technology Laboratories, Inc., previously a division of The Ramo-Wooldridge Corporation, became a separate company on October 31, 1958. Space Technology Laboratories will be directed by Lieut. Gen. James H. Doolittle, Chairman of the Board (after January 1, 1959); Dr. Louis G. Dunn, President; and Dr. Ruben F. Mettler, Executive Vice President. The other members of the Board of Directors are Robert F. Bacher, Head of the Division of Physics, Mathematics and Astronomy at the California Institute of Technology; James T. Brown, Vice President of the Mellon National Bank, Pittsburgh, Pennsylvania; and Samuel E. Gates, Attorney with the New York firm of Debevoise, Plimpton and McLean.

Space Technology Laboratories has the largest professional scientific and engineering staff in the nation devoted exclusively to Ballistic Missile and Space programs. STL is responsible for the systems engineering and technical direction of the Air Force Thor, Atlas, Titan, and Minuteman ballistic missile programs. While it does not engage in production, STL performs experimental and analytical research projects in advanced space technology, including the fabrication and assembly of special equipment and the conduct of test programs. A recent example is the lunar probe project assigned to STL by the Air Force and the National Aeronautics and Space Administration.

Space Technology Laboratories, Inc., plans to maintain a combination of technical competence and organizational strength appropriate to its special and continuing role in the important national program of space weapons development.

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CORPORATIONS

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Thompson Ramo Wooldridge will be directed by J. D. Wright, Chairman of the Board; Dean E. Wooldridge, President; Simon Ramo, Executive Vice President; and F. C. Crawford, Chairman of the Executive Committee. The other members of the Board of Directors are B. W. Chidlaw, A. T. Colwell, J. H. Coolidge, H. L. George, R. P. Johnson, and H. A. Shepard. Each is a Vice President of the merged company.

Thompson Products, Inc., has been for many years a large manufacturer of components and accessories for the automotive and aircraft industries. In recent years, it has also been active in the fields of Missiles, Electronics, and Nuclear Energy. Thompson has concentrated on products which require a high level of competence in engineering and precision manufacturing.

The Ramo-Wooldridge Corporation was organized five years ago to conduct research, development, and manufacturing operations in the field of electronic and missile systems having a high content of scientific and engineering newness. In addition to the work performed by Space Technology Laboratories, Inc., Ramo-Wooldridge has been engaged in major systems work in such areas as digital computers and control systems, communications and navigation systems, infrared systems, and electronic countermeasures.

The merger of the two companies into Thompson Ramo Wooldridge Inc. is intended to provide an integrated team having strong capabilities for scientific research, engineering development, and precision manufacturing.

Thompson Ramo Wooldridge Inc.

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. . . *Juno II*

the above timetable are considered unfavorable for launch. The moon will be in conjunction (between the earth and sun or New Moon) on December 10. Therefore if the payload were launched on those dates (8th or 9th) it would arrive in the vicinity of the moon at the conjunction and if it passed the moon it would proceed on into the sun instead of an orbit around it.

Furthermore, the tracking stations have requested that no launches be made when the moon is in conjunction. Radio signals from the sun could almost black-out the payload's transmitted data when traveling in the direction of the sun. The three *Pioneer* probes were all fired at or near the time of new moon.

• **More sophisticated detector**—Although the Air Force project, had it been successful, would have been a greater feat and provided more data, the Army probe will have a more sophisticated detector system to measure both cosmic and solar radiation. The Army rocket will have two counters. The Air Force probes had only one.

Each counter will pick up different ranges of energy, at a different counting rate (particles per second). The low counter will measure in more detail. The high counter will give a better picture of the intensity.

If the December shot fails, Army probably will not fire again until February. It takes about two weeks to prepare the rocket and a January attempt would cut deeply into Christmas and New Year holidays.

The instrument package will also contain an optical device incorporating a photoelectric cell from which the scientists hope to get measurements to guide them in deciding on a "picture-taking device" for use on future probes.

Two Symposiums Tackle Space Medicine Problems

SAN ANTONIO—Scientists at two space medicine symposiums recently exchanged ideas on how to keep future space explorers in top shape—mentally, physically and emotionally. Their views came out of the Second International Symposium on the Physics and Medicine of the Atmosphere of Space at San Antonio and the British Interplanetary Society's Symposium on Space Medicine in London.

It was generally agreed that man is emotionally equipped and can be physically equipped to handle a few weeks' run in outer space but interplanetary travel poses new problems, such as: How do you keep a space crewman well fed if he turns up his nose at algae puddings? How do you shield him from known and unknown radiation dangers? How would a space "lifeboat" work best? How do you keep him from getting bored? How do you provide an "umbilical cord" to Mother Earth so he doesn't feel completely detached from his fellow beings?

• **Outcome**—Suggested answers: Convert the algae to more appetizing form by feeding it to slugs, snails or water fleas. (There was some question whether the spaceman would find water-flea steak more tasty than the algae soup which space doctors have been advocating as a rich source of protein.)

Protect him from high and low-energy radiation particles with layers of various metals plus hydrocarbons. Make the escape capsule self-sufficient and an integral part of the vehicle, allowing it to eject the damaged or non-functioning part of the ship.

Give him at least one companion and give him enough jobs to do which he believes important to the mission. No suggestions were forthcoming on an ersatz umbilical cord, except that the matter requires extensive study.

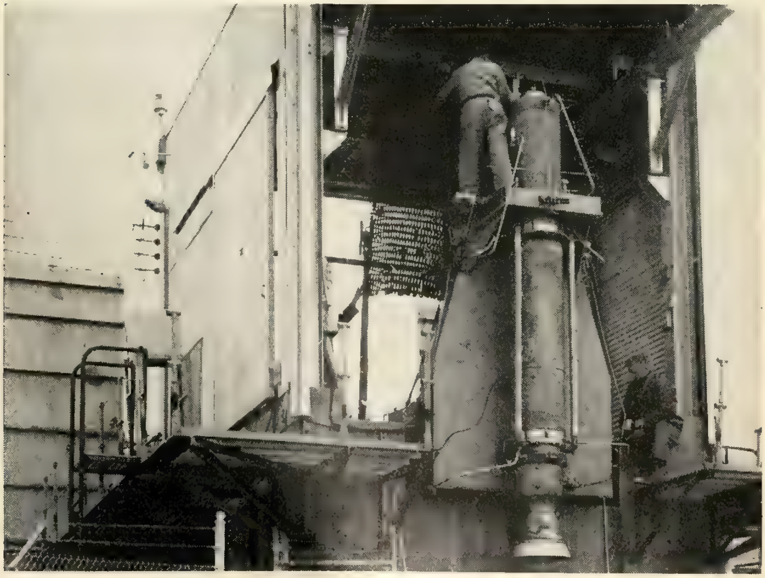
• **Food**—Bacteriologist Robert G. Tischer of Mississippi State University made the algae suggestion. Tischer said if the space crew is not likely to eat algae directly, then the interposition of an animal that would eat algae would yield animal protein food for the space crew. He also suggested microbial protoplasm "perhaps with modifications and the addition of flavors," as another bill of fare. But the consensus is that there still is no practical solution for palatable nutrition in the closed ecological system required in long space trips.

• **Radiation**—Dr. S. Fred Singer of the University of Maryland proposed a complex radiation shield composed of an outer layer of lead, a layer of tin, a layer of aluminum, magnesium or titanium, and finally a thin layer of plastic or other hydrocarbons to stop a substantial percentage of the high-energy radiations.

Consensus of several scientists is that radiation is a hazard that needs more study, that it can be dealt with, and that reaction to it is a question of individual response as well as dosage.

• **Escape**—Al Mayo of Douglas Aircraft—El Segundo suggested that instead of an escape vehicle, the nucleus of a space craft, housing the controls, should be complete in itself and would function as a spatial life raft while the malfunctioning or damaged portions "escape" through ejection.

Reaction's 'Packaged Liquid' Stand



THIS 19 FOOT liquid powerplant has been installed at Reaction Motors' Lake Denmark, N.J. for test and evaluation. As an example of the short development time involved in building packaged powerplants in different sizes, this large unit was first tested within three months of the time work was begun on the *Guardian* engine project.

What's new in TITANIUM welding:

Resistance and fusion welding as fabrication procedures have become increasingly important with the advent of missiles and aircraft designed for sustained operation at Mach 3 and better.

Titanium alloys are available which provide fusion-weld efficiencies of 100 percent, and spot-welded joints with excellent load carrying capacities.

Through its new Toronto, Ohio, rolling mills —designed specifically for titanium operations —Titanium Metals Corporation of America can provide light-gage flat-roll weldable products of consistently highest quality, on the fastest delivery schedules, at the lowest possible price in the industry today.

Q. What are the leading welding grades?

A. Ti-75A, a single-phase unalloyed grade which is readily formable; Ti-5Al-2.5Sn, a single-phase alloy grade which provides excellent resistance to oxidation up to 1200°F; and Ti-6Al-4V, a duplex-phase alloy grade with guaranteed minimum tensile strengths to 130,000 psi. Guaranteed minimum mechanical properties of these grades are:

GRADE	DENSITY lb/cu in	Guaranteed Room Temperature Properties		
		0.2% YS	UTS	Elong, % in 2"
Ti-75A	0.163	70,000	80,000	20
Ti-5Al-2.5Sn	0.162	110,000	115,000	10
Ti-6Al-4V	0.161	120,000	130,000	10

Q. Are special precautions required for welding these grades?

A. Titanium is spot-welded more readily than aluminum and many of the carbon and low alloy steels, and requires no special precautions. Spot-weld machine settings used for titanium and stainless steel are very similar.

Titanium is fusion-welded with inert-gas-shielded arc welding techniques and joint designs which are also similar to those used for other metals. Two fundamental principles must be considered:

1. Coated electrodes and other fluxing compounds cannot be used.
2. Titanium weld joints must be shielded from the normal atmosphere with an inert blanket of argon or helium during welding.

Q. Does that mean chambers are mandatory for fusion weldng?

A. No. Open air welding is adaptable to production operations when both root and face of the weld are protected from the air. Small parts and complex shaped weldments which are difficult to shield adequately may still be welded more easily and economically inside a chamber. This is described in detail in TMCA's publication, *Titanium Welding Techniques,* Engineering Bulletin #6.

Successful titanium welding techniques have enabled fabricators to produce missile propellant storage bottles which resist internal pressures of 8000 psi at —300°F. This all-titanium bottle, produced by Rheem Manufacturing Company, Downey, Calif., is Ti-6Al-4V, fusion-welded in an argon atmosphere. Designers say use of titanium bottles can add up to 700 miles to the range of an IRBM.

Q. Are titanium welds more susceptible to corrosion attack than the base metal?

A. Titanium welds offer the same excellent corrosion resistance as the base metal. Stabilizing heat-treatments, employed with many other materials, are *not* required.

Successful welding is a key factor in today's designs. It enables designers to draw upon titanium's unique combination of properties: light weight, corrosion resistance, and ability to withstand operating temperatures from -300°F to 1000°F — for the added performance vital to these uniquely critical times.

Titanium Metals Corporation of America has just completed the first comprehensive study of welding techniques yet published by the industry. This 32-page publication draws upon metallurgical considerations to recommend and explain techniques required for quality titanium weldments.

Titanium Welding Techniques, as well as other publications, in the most extensive data library in the industry, is available from Titanium Metals Corporation of America, 233 Broadway, New York 7, New York. This important literature is yours for the asking.

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military electronics

ASW AND UNDERSEA WARFARE

SE	Submarine communications and detection.
SE	ASW data processing and display aids.
PP	ASW listening and retransmitting devices.

MISSILE AND DRONE CONTROL

SE	Precision inertial-guidance system for short range air-to-surface missile.
SE	Bomber defense missile system.
DS	Homing guidance system for attack and reconnaissance drones.
DS	Air-to-air radar guidance system.
DS	Surface-to-surface radio inertial guidance system.
DS	Drone command guidance system.
PP	Data transmission and processing for surface-to-air missile guidance.
PP	Surface-to-air radar guidance system.

SPECIAL DEVICES

SE	Proximity warning.
SE	Long range electronic surveying equipment with airborne repeater.
DS	Electronic fusing.
DS	Electronic surveying equipment.
DS	Pulsed light range measurement equipments.
PP	Radiosonde transmitter and preamplifier.

SENSORS

SE	Precision location of radars.
SE	High precision and high resolution forward-looking radar.
DS	VHF homing beacon for supply-drop aircraft.
DS	Anti-jam radar transmitter and receiver.
DS	Radar anti-clutter receiver.
PP	Beacons, C-band and X-band.
PP	Strategic bombing radars.

COMMUNICATIONS AND DATA TRANSFER

SE	Obstacle-gain data transmission.
SE	18-Channel teletype.
SE	Noise-modulated data links.
DS	Integrated battlefield air mobile radio communication system.
PP	High-density FM voice multiplex.
PP	Integrated battlefield ground mobile radio communications system.
PP	High density UHF communication system for air defense.
PP	Coded secure communications.
PP	Pulse code modulated communication equipment.
PP	Multitone and digital selective calling equipment.
PP	Transportable and fixed-station microwave wide-band relay equipment.
PP	AM, FM and SSB voice and data communications equipment.
PP	I.F.F. equipment.
PP	Data link and logic for ground-to-air command guidance of aircraft and missiles.
PP	Miniaturized Transceivers.

Here is an unclassified look at representative Motorola militar
electronics programs...past and current. Necessarily incomplet
the listing includes only enough projects to demonstrate th
breadth of experience at Motorola's Military Electronics Divisio
For detailed information on how Motorola's capabilities can b
applied to your problem...or for data on engineering caree
opportunities...please write: Motorola, Inc., Military Electroni
Division, 8201 East McDowell Road, Phoenix, Arizon

KEY:

Program Status Coding (Reference MIL-E-5400B)

SE	*Study programs or programs resulting in experimental models.*
DS	*Programs resulting in developmental and/or service test models.*
PP	*Programs resulting in pre-production prototypes and/or production models.*

A-811-1

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COMPONENTS

Quartz crystal resonators and filters.
Electrical wave filters.
Electromechanical filters.
Precision V.F.O.'s and B.F.O.'s
Electromechanical reed filters and tone generators.
Transistorized power converters.
Transistorized voltage and current regulators.

ELECTRONIC WARFARE

DS	Battlefield electronic warfare.
DS	False target generation system.
DS	Tracking jammer.
PP	Subminiature passive radar illumination detector.

SOLID STATE MATERIALS AND DEVICES

SE	Ferro-electrics.
SE	Ceramics.
SE	Solid state devices.
PP	Ferrites.

NAVIGATION

SE	Doppler personnel navigator.
SE	Inertial sensors.
SE	Supersonic intercontinental bombing-navigation system.
SE	Hyperbolic battlefield navigation system for aircraft, land vehicles and man pack.
DS	Hyperbolic amphibious navigation system.
PP	Aircraft rendezvous and station-keeping systems.

GROUND SUPPORT AND TEST EQUIPMENT

PP	Phase-lock telemetry.
PP	Command destruct receivers.
PP	Guided missile test equipment.
PP	Programmed automatic test system.
PP	Aircraft test equipment.
PP	Militarized precision pulse circuit testers.

COMBAT SURVEILLANCE

SE	Drone guidance, data sensor, and data transmission integrated reconnaissance system.
SE	Aircraft data sensor, and data transmission reconnaissance system.
PP	High resolution side-looking radars for aircraft and drones.

DATA PROCESSING AND DISPLAY

SE	Automatic data processing for electronic countermeasures.
SE	Data processor for electromagnetic intercept.
SE	Threat evaluator for air defense.
PP	Shipborne electronic data system for air defense.
PP	Large-scope bombing radar indicator.

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Fusion 'Pinch Effect' Is Called Unpromising

Researcher Believes Controlled Thermonuclear Power Can Be Achieved by Revolutionary Microwave Heat Containment

by Raymond M. Nolan

WASHINGTON—The "pinch effect" for controlled thermonuclear fusion, as known now, does not offer much promise for the future.

That is the opinion of RCA's E. W. Herold, who devoted himself to the subject of controlled fusion at this year's Electron Devices meeting in Washington. In his paper titled, "Controlled Thermonuclear Fusion," Herold said that the U.S. is undoubtedly the world leader in research aimed at harnessing thermonuclear fusion for the production of power. At the same time, he warned that "it would be dangerous to predict the long-range future trends, since a single new idea, in the hands of even a small competent group in any country, could change the rate of progress markedly."

Herold is Associate Project Manager of C. Stellerator Associates, an RCA-Allis Chalmers engineering staff organization that is designing and building a major fusion research facility for Princeton University and the Atomic Energy Commission.

• Maintaining controlled fusion—One intriguing theory of Herold's is that fusion power may some day be achieved by revolutionary all-electronic techniques, instead of by the combined electronic and electrical methods envisioned on the basis of present research programs.

As an example, he mentioned new microwave techniques to contain the 100-million degree heat needed to produce and maintain a controlled fusion reaction. Since no known material can contain more than a few thousand degrees of heat, present research is in the area of magnetic fields using the pinch effect for greater heating.

However, Herold feels that a definite breakthrough is needed to reduce the power needed to maintain a steady magnetic field over a volume of many cubic feet. Even better, he said, would be a containment method using radio frequencies to react upon the superheated deuterium gas that serves as the fusion fuel. He feels that it might be possible to set up containing microwave fields around the superheated plasma in somewhat the manner that super-high frequency waves are guided along solids in certain communications techniques. This would somewhat resemble a dielectric wave guide, reduced in magnitude with distance, so that wall losses could be cut down.

As Herold sees that problem, it would not have any immediate application to missiles or space craft since another part of the problem would be the megawatts of C-W power at microwave frequency needed to maintain the containment. However, he challenged his audience to discover a way to find the necessary power. When someone does, the near-ultimate generation of missiles, the electronically-propelled ones, will be much closer to reality.

• Power direct from neutron—Or perhaps the required energy will come from new ideas suggested by Herold, such as a method to produce power directly from the neutron without going through the heat cycle. He cited the analogy that a radio engineer uses the motion of charged particles to achieve power and said that this effect may someday be part of fusion reactors also.

But containment is not the only area where Herold sees a need for application of electronics. In a paper published this summer, he stated that in his opinion, the greatest contribution to thermonuclear fusion can be made by the radio-electronic engineer paying attention to the problem of ignition and heating.

He outlines the problem by mentioning some of the difficulties incurred in heating by the passage of direct current through a plasma. Because electrons travel 60 times as fast as deuterium ions, they carry most of the current, and this form of heating is effective mainly on electrons, tending to raise their temperature but not that of the ions, except after many thermalizing collisions. In addition, as the temperature rises, the resistance goes down and the I^2R loss decreases, since induced currents are normally limited by the plasma inductance. Thus, such heating appears to be self-limiting. On the other hand, if some way is found to heat the ions without heating the electrons, the cooling effect of the electrons will be a problem.

• Hopeful of high power radio—In radio-frequency heating, there are some peculiar skin effects in a plasma to consider. These are long mean-free-paths and magnetic constraints on the particle paths. The cyclotron frequencies of charged particles in a magnetic field are, quantitatively: (in cps)

Electron cyclotron frequency= $2.9 \times 10^6 B$,

Deutron cyclotron frequency= 770B,

Triton cyclotron frequency=510B,

Alpha particle cyclotron frequency =770B.

Since B equals 26,000 gausses, these correspond to 75,000 mc for electrons, 20 mc for deutrons and alpha particles, and 13 mc for tritons.

Herold feels that high-power radio frequencies, which are adapted to the plasma characteristics, and to the ion and electron dynamics, offer great hope, both for containment and the ignition problem. If containment time is very short, he says, very high power radio frequency may supply the rapid heating necessary to achieve useful results.

• Plasma problem more complex—In his paper, Herold cited the case of electronics engineers understanding containment of low-density electric charges by magnetic fields because this

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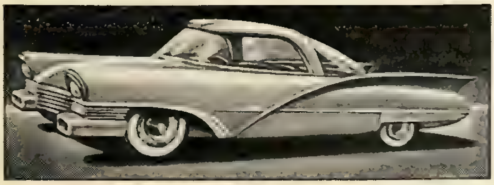
The steel plowshare was the basic agricultural tool when Wyman-Gordon was established seventy-five years ago. At that time, it took approximately 50 per cent of the nation's work force on farms to produce food for our country's needs.



With today's mechanical farm implements, it requires only 12½ per cent to feed our people. The development of modern farm implements, motor cars, trucks and tractors, railroad locomotives, and the "Mach era" aircraft and space vehicles, would have been impossible without forgings.

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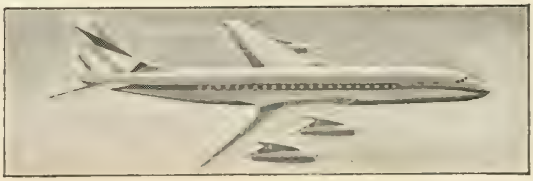

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For more information, write to: Vice President, Defense Products Marketing, Crosley Division, Avco Manufacturing Corporation, Cincinnati 25, Ohio.

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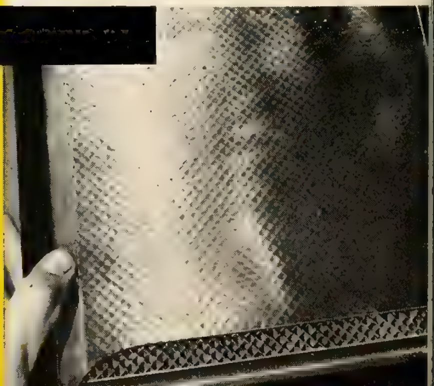
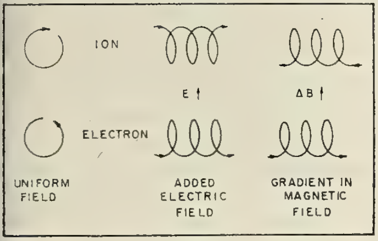


occurs in every magnetically focused electron tube, and in magnetrons when they are beyond cutoff. These simple concepts provide a start to understanding high-density plasma containment.



The diagram shows the simple case of an isolated ion or electron in a magnetic field. Such charges experience force at right angles to the magnetic field and to the perpendicular component of their own velocity. Only velocity components parallel to the field are unaffected. Thus, the particles, whether they be electrons or ions, are held to the magnetic field lines, rotating in circles, as shown at the left of the figure, and free to move back and forth along field lines. When there are other fields present such as the electric fields or there is a gradient of a magnetic field, the particles drift across field lines and are no longer contained. This is a phenomemon of containment since no way is known of establishing a uniform magnetic field with no gradients or magnetic forces.

With a plasma, the problem becomes more complex since the plasma is a good conductor and the current in it tends to set up its own field and disturbing force.

It is Herold's contention that the electron physicist, the electron tube engineer, and the radio engineer can all contribute new concepts to this field of gas discharge technology.

New Resistors Depend On Magnetic Field

The phenomenon of magneto-resistance is now being applied to resistor-type devices.

The new components operate on the theory of the magneto-resistive effect where solid state units exhibit an electrical resistance which is a function of an applied magnetic field.

Major advantage of the devices, called Magnetoresistors by their developer, Ohio Semiconductors Inc., is that they can be used to provide a low-noise variable resistance having no moving parts. Their most valuable application will probably be in the feedback and control systems area where fast response may be quite a bit superior to existing electromechanical systems.

Magneto-resistance is not a newly discovered phenomenon, but practical applications are recent. The reason for magneto-resistive practicality now is the use of highly purified and specially prepared high mobility intermetallic compounds such as indium antimonide and indium arsenide. With these compounds, the magnetoresistive effect becomes great enough for extensive practical applications.

In the resistor-type device, ratios of high-to-zero field resistance of more than 40 to 1 have been attained. The company anticipates that units with power dissipations of up to 100 watts will be available when production is underway.

High Temperature Research Described in OTS Reports

Three publications currently available from the Office of Technical Services, Department of Commerce, describe Air Force-sponsored research in the high temperature field. Two reports describe capacitors, one operating up to 250 C and the other to 500 C. The third report discusses research on aluminum antimonide for use in semiconductors operating up to 500 C.

Title of the first report is "250 C Ceramic Capacitor With Wide Temperature Range." It describes the development of titanate-based ceramic capacitors with high dielectric constants, small temperature coefficients and low loss factors with a temperature range from minus 65 C to plus 250 C at up to 1000 volts.

The final products in the research program were composed of 80.1% barium titanate, 16.99% lead titanate and 2.91% tantalum oxide. The processing methods are claimed to have resulted in higher degrees of mixing and greater reproducibility than was previously possible.

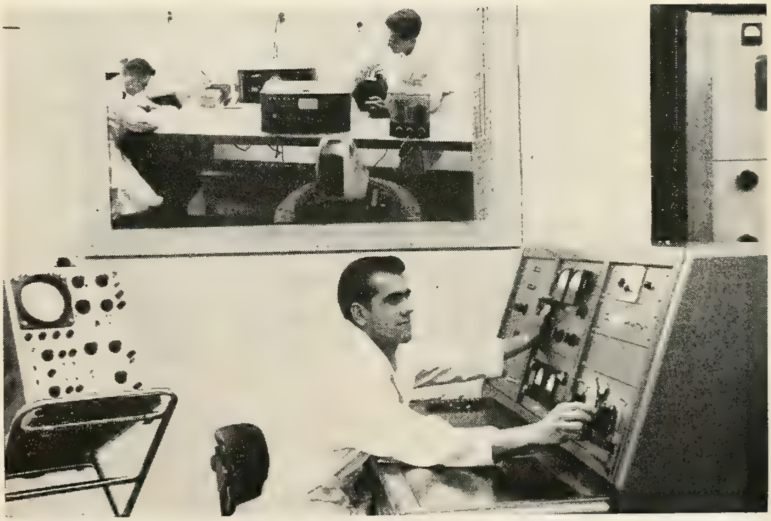
The other capacitor report is titled, "Research and Development on Ultra-Thermic 500 C Capacitors." These units were fabricated using successive layers of platinum and dielectric materials deposited by vacuum thermal evaporation.

Investigated during the program were the dielectric properties of oxides of such materials as aluminum, magnesium, zirconium and boron nitride to measure their resistivity throughout the required temperature range of the capacitors. The document reports that alumina and boron nitride yield satisfactory dielectric qualities in thin film form at high temperatures. Information is also included on techniques and processes involved in depositing thin dielectric layers.

The third report, "Research on Aluminum Antimonide for Semiconductor Devices," discusses research in the development of purification and crystal growing techniques for obtaining suitable aluminum antimonide material.

The study was conducted because aluminum antimonide was found to have the optimum potential for meeting the 500 C objectives.

Reliability Center for Missiles

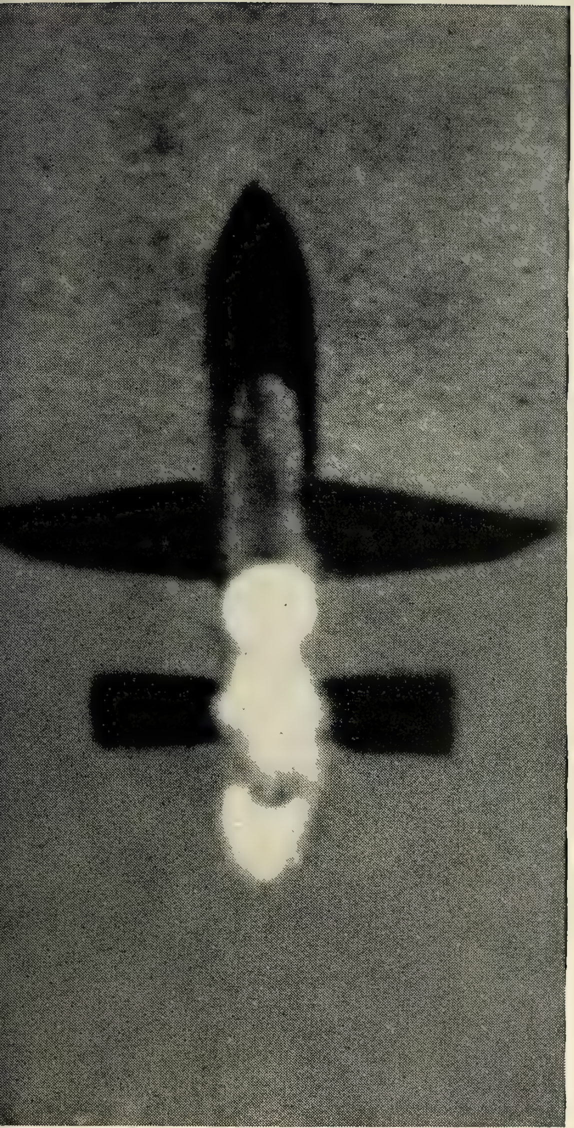


NEW PRODUCTION reliability center built by Leach Corporation will help to insure the more than 99.99% reliability required for missile components. Components undergo vibration in triple-walled silence chamber.

BRISTOL RAMJETS POWER

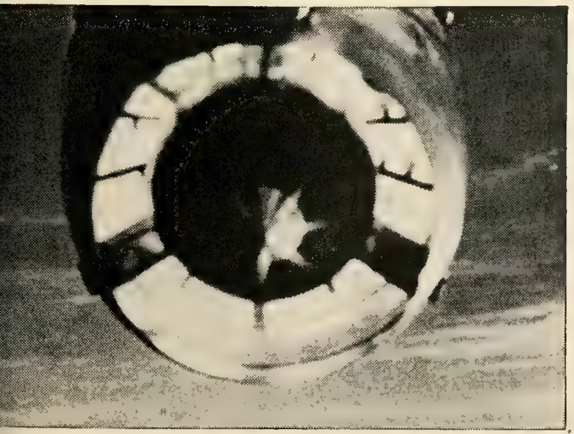
BLOODHOUND DEFENCE SYSTEM

—now ordered by Sweden



mjet-powered Bloodhound missile in supersonic flight

-up of ramjet air-intake during flight



Choice by European neutral confirms operational effectiveness of Bristol/Ferranti's surface-to-air guided missile system and its ramjet engines.

Adoption of the Bloodhound—already approaching full operational status with the RAF as mainstay of Britain's air defence—was made by a Swedish assessment team after exhaustive evaluation of the merits of surface-to-air guided missile systems available throughout the world.

Bristol ramjets—ensuring long range, flexibility, simplicity of handling—play a large part in making Bloodhound the most effective defence system of its kind in the world—*now and for many years to come.*

Bristol Siddeley

ENGINES LIMITED

Hawk May Be Built By NATO Countries

Five European companies, three Dutch, one French and one Italian, are understood to be very interested in manufacture of the Raytheon *Hawk* under license. The French firm of Sud Aviation is reportedly seeking to produce the missile in association with Italy's Fiat. The three Dutch firms believed to be interested are Philips, Fokker and Hollandse Signalapparaten.

Raytheon declined confirmation of the reports, saying only that negotiations are in an exploratory stage and no details have been decided. If any agreements are reached, it is presumed that Raytheon will provide technical assistance in the form of "know-how," proprietary information, while actual production would be under control of the NATO countries involved.

The United States is now awaiting proposals from a number of European countries on the subject of licensing agreements. Several Dutch firms are also seeking to produce *Sidewinder*, providing it would not be obsolete by the time it comes off the production line.

Industrial Park Under Development for Research

WASHINGTON—Newest evidence of the impact of missile work on the general U.S. economy is the establishment of a new industrial park development—to be devoted entirely to scientific research and development activities—on a 365-acre plot just north of Washington's city limits.

In Montgomery County, about eight miles northwest of the District line, the development is known as Washington-Rockville Industrial Park. It is said by its developers to be the first in the United States to be devoted entirely to organizations doing scientific and research work, largely connected with missiles and space flight.

Some 10 specially designed office and plant structures—each set in a park-like atmosphere—are under construction on the former farmland. It is expected that some 500 companies may locate on the site, for an initial construction and land expenditure alone of more than $50 million.

Soviets Release *Sputnik* Cosmic Ray Measurements

The Academy of Sciences of the USSR has published a report of some of the cosmic ray findings of *Sputnik* II, months after the satellite's demise.

The satellite had two similar instruments for the recording of cosmic radiation, each independent of the other. Each consisted of a charged particle counter with an operating length of 100 millimeters and a diameter of 18 millimeters. The average amount of matter surrounding the counter was 10 gram/cm^2. Operating voltage of the counter (400v) was provided with the aid of a semiconductor converter fed from a 6½ v battery.

Both instruments contained scaler devices made of semiconductor transistors requiring 0.1 watts of power each. Weight of the instruments and power supply was 5.5 pounds.

The noted change in the intensity of cosmic rays in relationship to altitude beyond the limits of the atmosphere could be due to three effects: the increase of intensity at the expense of decrease in the screening action of the earth; increases in intensity because the lessening of the earth's magnetic field leads to a decrease in the generation of the energy of particles which can penetrate through the earth's magnetic field; and the change of the albedo of cosmic radiation.

G. F. Metcalf Named To AIA Missiles Group

George F. Metcalf, Regional Vice President—Washington Defense Activities for the General Electric Co., is the new chairman of the Aircraft Industries Association's Guided Missile Committee. He succeeds C. R. Irvine of Convair who resigned.

The committee is composed of representatives of leading U.S. manufacturers of guided missiles. It is the focal point for the views of missile manufacturers on non-competitive matters dealing with the design, development and production of missiles.

when and where

NOVEMBER

The Convertible Aircraft Congress, designing and operating missiles from unprepared sites, Franklin Institute, Philadelphia, Penna., Nov. 28.

First Electronic Computer Exhibition and Symposium, Olympia, London, England, Nov. 28-Dec. 4.

DECEMBER

National Resources Conference, Industrial College of the Armed Forces, Departmental Auditorium, Washington, D.C., Dec. 1-12.

Third EIA Conference, Reliable Electrical Connections, Dallas, Texas, Dec. 2-4.

IRE and AIEE, Second National Symposium on Global Communications, Colonel Inn, St. Petersburg, Fla., Dec. 3-5.

Eastern Joint Computer Conference and Exhibit, Bellevue-Stratford Hotel, Philadelphia, Penna., Dec. 3-5.

Professional Group on Vehicular Communications, Ninth National Conference, Institute of Radio Engineers, Hotel Sherman, Chicago, Ill., Dec. 4-5.

Mid-American Electronics Convention, sponsored by Kansas City Section, Institute of Radio Engineers, Municipal Auditorium Arena, Kansas City, Mo., Dec. 9-11.

American Astronautical Society, Fifth Annual Meeting, Hotel Statler, Washington, D.C., Meeting will be held in conjunction with the 125th Annual Meeting of the American Assn. for the Advancement of Science, Dec. 27-30.

JANUARY

Fifth National Symposium on Reliability and Quality Control in Electronics, Bellevue-Stratford Hotel, Philadelphia, Penna., Jan. 12-14.

Southwest Electronic Exhibit, Arizona State Fairgrounds, Phoenix, Ariz., Jan. 21-23.

Fifth Annual Radar Symposium (classified), Rackham Bldg., University of Michigan, Ann Arbor, Mich., Jan. 27-29.

Society of Plastics Engineers, 15th Annual Technical Conference, Hotel Commodore, New York, N.Y., Jan. 27-30.

FEBRUARY

14th Annual Technical and Management Conference, Reinforced Plastics Div., Society of the Plastics Industry, Inc., Edgewater Beach Hotel, Chicago, Ill., Feb. 3-5.

IRE, AIEE 1959 Solid State Circuits Conference, University of Pennsylvania, Philadelphia, Pa., Feb. 12-13.

MARCH

IRE, AIEE and Association for Computing Machinery, 1959 Western Joint Computer Conference, Fairmont Hotel, San Francisco, Calif., March 3-5.

Gas Turbine Division of the American Society of Mechanical Engineers, turbine in action, Cincinnati, Ohio, March 8-11.

The American Rocket Society, 1959 Annual Meeting, Daytona Plaza Hotel, Daytona Beach, Fla., March 23-25.

Ryan has built every production rocket motor for America's first operational guided missile—the Army's Corporal—for over five years.

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■ Beginning January 5, 1959, MISSILES AND ROCKETS will move to a full technical-news weekly. There no longer will be a distinction between "Engineering and Electronics" and "News and Business" editions. Reader Service cards will be included in the 4th cycle and in the February 9th and July 20th Special Issues as well as the mid-May "Missile Market and Product Guide".

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AF Wins First Round With GAO

by Clarke Newlon

WASHINGTON—The Air Force has won the first round, at least, in its battle with the General Accounting Office and Congress that its detailed Inspector General investigation reports are privileged matters. But Air Force was left with the clear threat that future legislation may drastically alter the situation.

In testifying before the Moss committee, Air Force Secretary James Douglas strongly defended the right of the Air Force (and implicitly all the services) to withhold certain details of an IG investigation into alleged delays and excessive costs of the long range missile development program.

He was given a last minute assist from the White House by way of a letter from the President to Rep. Clare Hoffman, a Republican committee member, upholding the AF position. This was, in effect, that the summary and some 35 pages of the report (of a total of 61) in detail, were really all the GAO needed to know.

• **Several possibilities**—Next move is up to the legislative branch and Congressman Moss and the GAO are mulling over several possibilities:

1. To continue an independent investigation by the GAO of "deficiencies" the Inspector General found in the AF missile development program.
2. Agreements between Moss, Carl Vinson, chairman of the House Armed Services Committee; William Dawson, chairman of the House Government Operations Committee; Clarence Cannon, chairman of the House Appropriations Committee and Sub-Committee Chairmen George Mahon and Edward Hebert—to introduce a rider on the next Defense Department appropriation bill making it mandatory to turn such IG reports over to the GAO in toto on request.
3. To reintroduce a bill originated at the last session by Rep. Porter Hardy to strengthen the GAO position. This bill specified that any official failing to comply with Section 313 of the Budget and Accounting Act of 1920 (making it mandatory upon the services to turn over any requested material to the GAO) would not only forfeit his salary during the period of such refusal but would be subject to a $5,000 penalty.

• **Areas criticized**—In the summary of the Air Force report as released by the Moss committee, the IG was critical of:

Contractors using overtime as a subterfuge to get around salary and work week limitations, thus increasing program costs.

Purchases by some contractors which do not meet AF standards, resulting in delays and excessive costs.

Leasing of equipment when similar equipment was available in the industrial reserves.

Some contractors failing to get approval for cost-plus-fixed-fee contracts, a violation of military regulations.

Some operations of Ramo-Wooldridge Corp, which directs much of the AF missile program.

Lack of follow-through on contract supervision.

DOD Taking Good Look at Cutting out Missiles

WASHINGTON—There are too many different missiles in the U.S. arsenal and the Department of Defense is taking a long look at the whole field to decide what and where to cut, according to Secretary McElroy.

"We have a proliferation far beyond what is wise," McElroy said, "and some of the marginal programs in the missile field will be cut out."

Important among these is the *Thor-Jupiter* IRBM decision, and the official answer will be announced before the end of the year. Anti-aircraft missiles presently can't replace interceptor aircraft, he continued, but they reduce the requirements.

"We would not eliminate those *Thor*'s and *Jupiters* already ordered," McElroy said, "but the farther we go in making ICBM's operational, the less interesting it is to deploy IRBMs."

The four *Thor* squadrons for Britain are firm, McElroy said. He said he considered both *Thor* and *Jupiter* operational missiles, notwithstanding recent test failures.

Budget discussions are in full swing, but the Secretary would give no indications as to what increase might be expected, or how the money would be split up between the services. He did say that a recent five per cent increase over the 1959 budget attributed to Deputy Secretary Quarles was hedging. He did say he expected no difficulties stemming from the Congress as the issues were so great as to override any partisan considerations.

contract awards

AIR FORCE

By the Air Research Development Command, Baltimore, Md.:

The **Data Tape Division, Consolidated Electrodynamics Corp.,** has received a $216,900-contract for magnetic-tape recorder/reproducer equipment that will be used with range instrumentation previously supplied to the Air Force Missile Test Center, Patrick Air Force Base, Fla.

By AMC, Wright-Patterson Air Force Base, Ohio:

Northrop Aircraft Inc., Northrop Division, Hawthorne, Calif. received $150,000 for augmentation of ground equipment for launch crew training for SM-62A program.

McDonnell Aircraft Corp., St. Louis, Mo. received $500,000 for development of quick-loading capability for GAM-72.

By San Antonio R&D Procurement Office, Wright Air Development Center, Air Research and Development Command, U.S. Air Force, Lackland AFB, Texas:

Minneapolis-Honeywell Regulator Co., Aeronautical Div., Minneapolis, Minn. received $179,928 for design, development, fabrication and installation of a space cabin simulator.

Burroughs Corp. received a $22.8 million-contract for additional 32 data processing systems in the SAGE (Semi-Automatic Ground Environment) continental air defense program.

ARMY

By the Department of the Army.

J. W. Bateson Co., Inc., Dallas, Texas, received a $1,273,000-contract for construction of a guidance building, antenna foundation and transmitter building at White Sands Missile Range, New Mexico.

By District Engineer, U.S. Army Engineer District, Fort Worth Corps of Engineers, Fort Worth, Texas:

King Construction Co. and Associates, Texarkana, Texas received $4,142,564 for *Nike-Hercules* facilities, Alvarado, Denton, Mineral Wells and Terrell sites, Dallas-Fort Worth defense area.

By Corps of Engineers, Office of the Dist. Eng., Tullahoma, Tenn.:

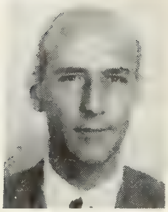
Blount Bros. Construction Co. received $1,797,395 for construction of second increment, plenum evacuation system, propulsion wind tunnel, and Arnold eng. development center, Tullahoma, Tenn.

By Purchasing and Contracting Div. White Sands Missile Range, New Mex.:

Ampex Corp., Los Angeles, received $28,650 for one recorder/reproducer.

By U.S. Army Engineer Dist., Corps of Engineers, Mobile, Ala.:

Warren, Knight & Davis, Birmingham, Ala., received $99,800 for architect-engineer services in connection with Redstone Arsenal, Ala.



propulsion engineering

by Alfred J. Zaehringer

Working fluids for an atomic rocket are being studied by Bell Aircraft Corp. engineers. Hydrogen is best if there is a temperature limitation. However, helium is superior where power is limiting. At 2,000°K and 20 atm pressure, for example, hydrogen produces an I_{sp} of 664 sec for a pile power of 21 kw/lb thrust. For helium, under the same conditions, a power of 12 kw/lb thrust would produce 389 sec.

Two new boron fuel processes might reduce present costs. Utilizing a Linde-type process, an alkylated borane could be produced by direct reaction of diborane with acetylene. Ziegler process, using triethyl aluminum, reacts boron fluoride and borax to form the boron alkyl.

Propulsion for torpedoes or underwater rockets utilizes alkylaluminum hydrides. Aluminum alkyls are also claimed in a new patent issued to duPont. The compounds bridge the gap between the straight metal alkyls and the boron hydrides.

Temperature is important when testing the sensitivity of monopropellant materials. Los Alamos Scientific Laboratory found this to be true when testing nitromethane. The effect of sample size and effective diameter are also important.

Solid propellant performance data is becoming more available. Ammonium perchlorate with polybutadiene acrylic acid plus aluminum powder gives an I_{sp} of 250 sec. Ammonium nitrate with cellulose acetate yields 171 sec. Ammonium perchlorate and polyurethane offers 238 sec. A mixture of ammonium perchlorate and potassium perchlorate produces 236 sec. Potassium perchlorate with a polyester (styrene) resin has a 178 sec. potential. All data are theoretical figures calculated at 1,000 psi pressure. The figures may not be representative of classified combinations, which may be higher or lower in performance when obtained in actual rocket systems.

Polysulfides out for solid propellant fuel-binders? Claim is that Thiokol may switch over to the chloroacetals. Other possibilities are ethyleneketal or thioketals. Other companies are working on urethanes, butadienestyrene, and acrylated butadienes.

Solids south of the border: Wolff & Co., of Buenos Aires, Argentina, has been very active in the field of solid propellants. The firm recently acquired German patents for propellants which are blends of nitrocellulose, nitrated polyalcohols, and a molten nitro compound.

Propellants for atomic rockets have been screened by AEC. Liquids are preferred working fluids. Water, though good, would have a molecular weight of about 18 at high pressures and temperatures inside a pile. Nitrogen compounds (such as ammonia or hydrazine) would be at 8½-10½; alcohols would be decomposed to 9-10 while hydrocarbons would be 5½-8. Helium is near 4 while hydrogen would be 2. Hydrogen thus appears as best bet (performance wise) for high I_{sp}, while the hydrocarbons would be suitable for medium performance.

More performance data on plasma jets: Giannini Plasmadyne Corp. reports that they have achieved thrusts of ½-2 lb with argon at a power input of 40-60 kw on 1-4 gr/sec mass flow; I_{sp} is 140-214 sec. With helium, thrusts of ½-1½ lb have been attained on mass flows of 0.7-1.3 gr/sec with inputs of 80 kw. Performance of He is higher—amounting to 530-590 seconds.

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advertisers' index

Aerojet-General Corp., Sub-General Tire & Rubber Co. 10
  Agency—D'Arcy Adv. Co.
American Beryllium Co., Div.-Visioneering Co., Inc. 21
  Agency—Gilmore-Rice Adv.
Avco Mfg. Corp. 43
  Crosley Div. 34
  Agency—Benton & Bowles, Inc.
Bristol Aero-Engines Ltd. 36, 37
  Agency—Young & Rubicam, Ltd.
Bristol Aircraft Ltd. 19
  Agency—Young & Rubicam, Ltd.
Canadian Steel Improvement Limited 24
  Agency—Cockfield, Brown & Co.
Diversey Engineering Co. 6
  Agency—Roark & Colby Adv., Inc.
Hydro-Aire, Inc. 2
  Agency—Gaynor & Ducas, Inc.
Janitrol Aircraft Div., Surface Combustion Corp. 12
Marman Div., Aeroquip Corp. 3
  Agency—The Fred M. Randall Co.
Motorola, Inc., Military Electronics Div. ..30, 31
  Agency—Compton Adv., Inc.
North American Aviation, Inc.
  Autonetics Div. 4
  Missile Dev. Div. 8
  Rocketdyne Div. 14
  Agency—Batten, Barton, Durstine & Osborn, Inc.
Northrop Aircraft, Inc. 22, 23
  Agency—Erwin Wasey, Ruthrauff & Ryan, Inc.
Ryan Aeronautical Co. 39
  Agency—Batten, Barton, Durstine & Osborn, Inc.
Scaife Co. 15
  Agency—Roark & Colby Adv., Inc.
Space Technology Laboratories, Inc. 26, 27
  Agency—The McCarty Co.
Thiokol Chemical Corp. 44
  Agency—Dancer-Fitzgerald-Sample, Inc.
Thompson Ramo Wooldridge, Inc. 26, 27
  Agency—The McCarty Co.
Titanium Metals Corp. of America 29
  Agency—W. L. Towne Adv.
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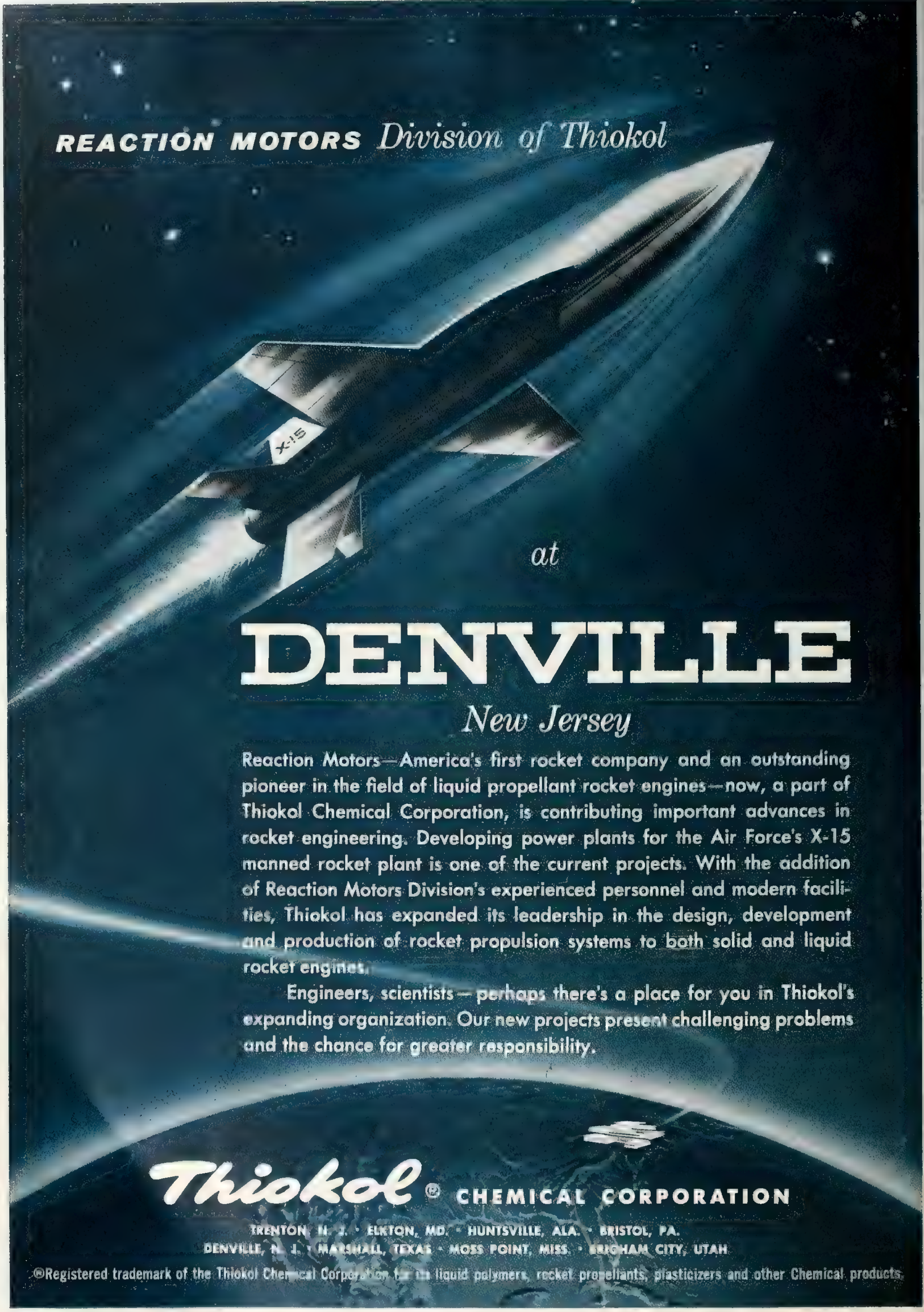

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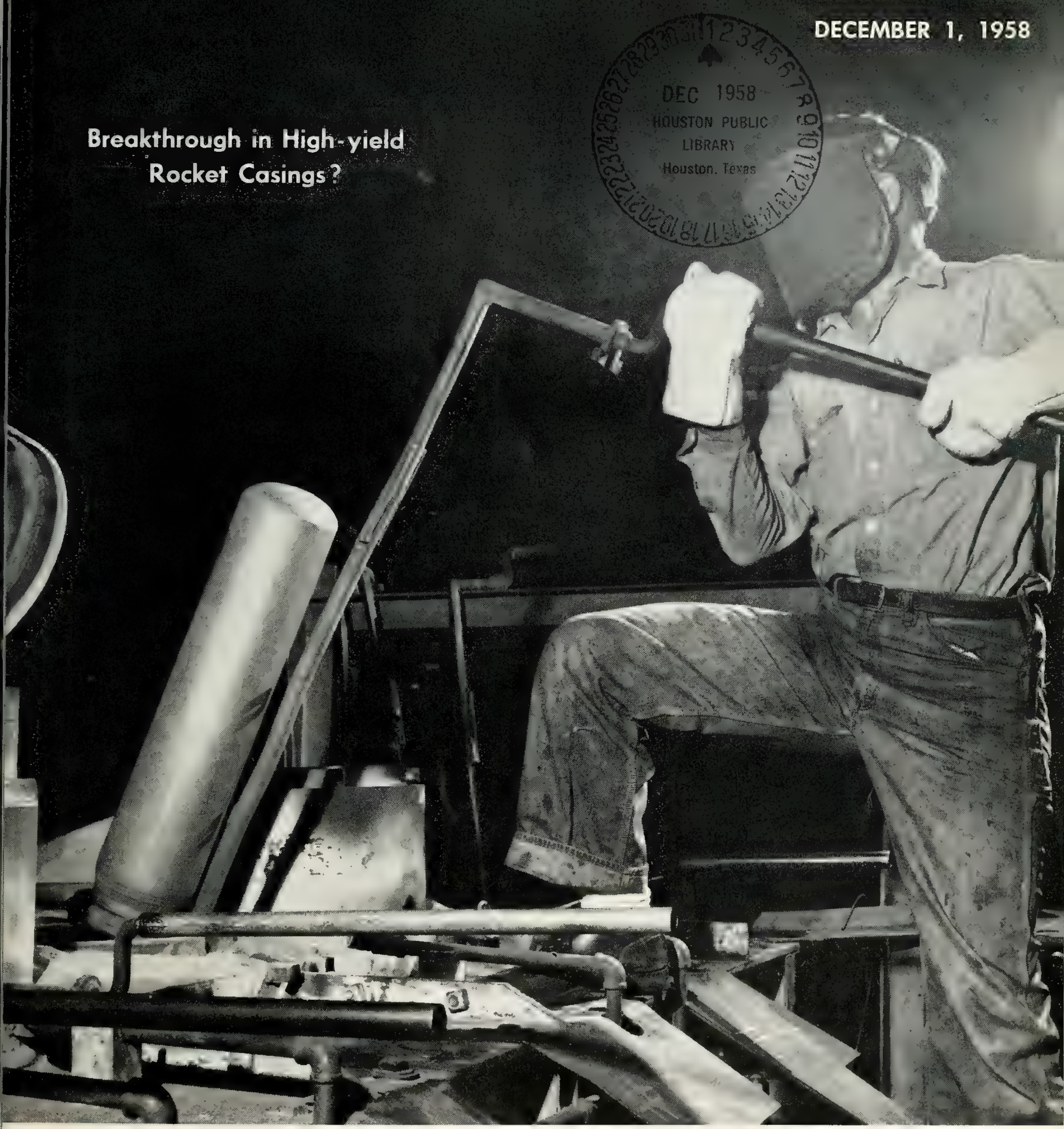

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

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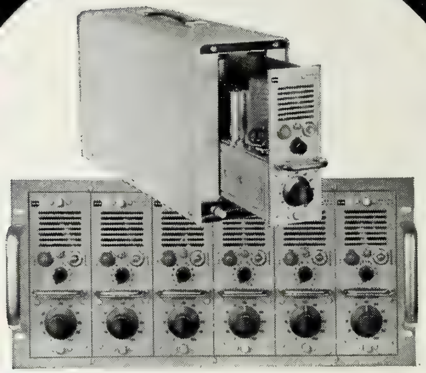

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±2 microvolt stability ■ <5 microvolt noise ■ 40 kc bandwidth ■ 100 KΩ input, <1 ohm output impedance ■ Gain of 20 to 1000 in ten steps with continuous 1 to 2 times variation of each step ■ ±45 V, ±40 ma output ■ 1.0% gain accuracy ■ 0.1% gain stability and linearity ■ Integral power supply

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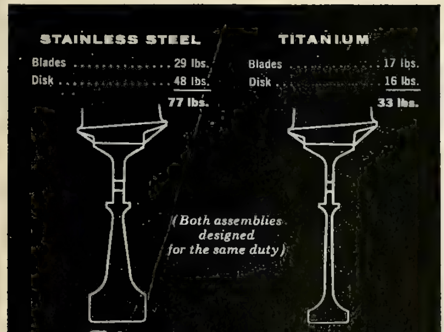

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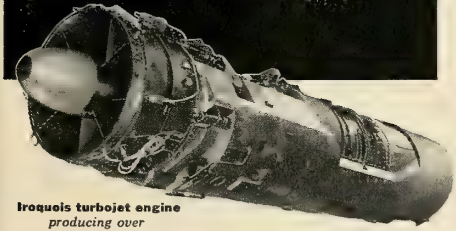

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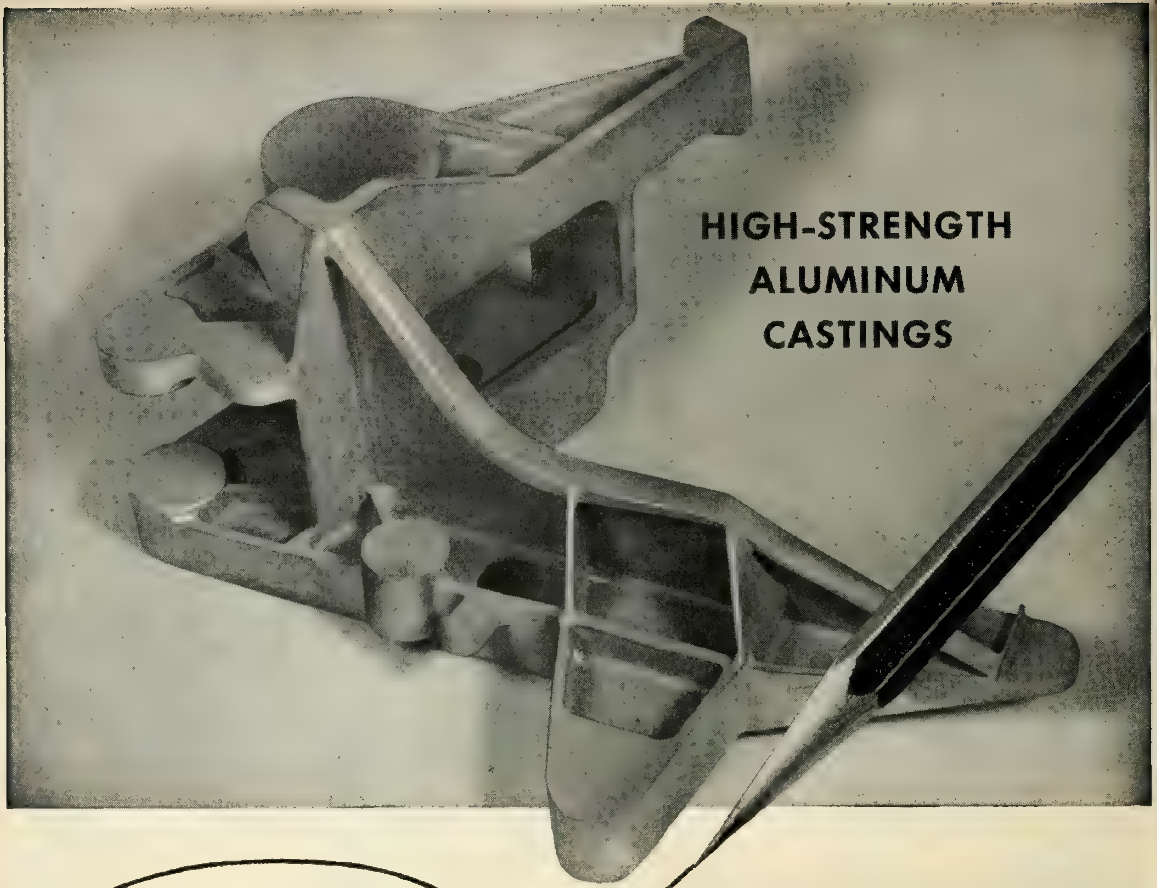

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COVER: *A Falcon motor case undergoes an oil "bath" at the Scaife Co. of Oakmont, Penn., prior to heat treatment. This is another example of how industry is finding new and better methods of forming and fabricating rocket metals. (Story on p. 25.)*

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in this issue

DECEMBER 1 HEADLINES

Air Force Answers *Polaris* with *Bold Orion*
Two-stage solid propellant with 1,000 mile air-to-surface range is revealed in m/r exclusive 11

Special American Rocket Society Section
- **Pictorial Highlights of Annual Meeting** 12-13
- **ARS Session Devoted to Future Developments** 14
- **Abstracts of ARS Technical Papers** 17-23

Vandenberg Readies for First Missile Firings
Sentry sattelite expected to be fired from *Thor* pad about December 19th 51

Decision Expected Soon on U.K. Space Program 51

ASTRONAUTICS ENGINEERING

Motors Development Depend on Alloys
Industry pioneers new methods to form and fabricate better rocket casings 25

MISSILE ELECTRONICS

New Concept in Data Handling Equipment
Telemetering units analyze data before transmission to ground equipment 31

Lockheed Develops New Energy Conversion Method 37

DEPARTMENTS

Washington Countdown 7
Industry Countdown 9
Astrionics 47
Space Age 48
When and Where 57
Contract Awards 59
Editorial 62

Newest

HONEYWELL MINIATURE RATE GYROS

Typical M Series Gyro undergoes 20 G Linear Vibration Test with no deterioration of performance.

Rugged enough to withstand 100 G shock

Model M-1
shown actual size

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WEIGHT: 4.5 ounces

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washington countdown

Future looks grim . . .
for press coverage of launchings from Pacific Missile Test Range. Navy reportedly is trying to lease—for obvious security reasons—privately-owned hilltops overlooking Point Arguello site. Air Force could do the same thing for the Point Sal site, which incidentally is already seeing newsmen setting up quarters for first launch. *Sentry* satellite is expected to go between December 15-19 from Vandenberg.

***Jupiter*-C nose cone . . .**
recovered in August, 1957 and shown on television during President Eisenhower's post-*Sputnik* speech has been presented to Smithsonian Institution. Only one thing was missing —the letter from Army scientists to Maj. Gen. J. B. Medaris. Medaris had it with him in Paris where he was attending the NATO Parlimentarian meeting. However, he promised to turn it over to the Smithsonian upon his return.

A form letter . . .
to answer queries about staking claims on the moon and other planets has been prepared by the Department of the Interior. In part it says: "It is not now nor has it ever been possible for anyone to make application for or obtain the right to land on the moon or planets through the United States Government." Mail of this sort has been on a steady increase since *Sputnik I,* the Department says.

Nixon's press advisor . . .
and administrative assistant William Key, will leave that political post about December 1 and return to his old job as chief of public relations for Fairchild Engine and Airplane Corp. at Hagerstown, Md. Ex-Atlanta City Editor Key took the vice presidential spot about one year ago under considerable persuasion.

Newsmen getting educated . . .
as scientific and technical agencies in the Washington area help them to obtain a basic education in space matters. NASA recently had a briefing on basic facts of space flight. Last week, the U.S. Naval Observatory offered a special briefing on astronomy and space concepts. The Navy briefing covered space navigation, prediction of orbits, aiming space vehicles and allied subjects.

Isolated duty pay . . .
up to 40% is being considered by the Air Force for some personnel who will be manning missile bases and warning sites in remote areas. Cost is estimated at $16 million for 1960.

Armed services are unhappy . . .
with some of the personnel acquiring practices of NASA. Army Ordnance Missile Command is probably the saddest, but other agencies aren't smiling either. At Naval Research Laboratory, officials complain that the new agency took an additional 50 scientists and engineers in addition to the *Vanguard* team. Some 10 other government agencies, including the AEC, reportedly are involved. However, NASA spokesmen say that all transfers are proceeding in a planned and orderly manner.

Supreme court ruling . . .
involving income tax deductions may hold some unpleasant surprises for missile industry personnel. Court took up the case of Douglas employees who deducted meals, lodging and travel costs, claiming their transfer to another base was temporary. The court ruled that board and lodging at job sites away from established residences cannot be claimed.

Future spacemen . . .
might well ponder a report which came out of the recent convention of the Association of Military Surgeons. According to Capt. William R. Stanmeyer, USN, men living in a closed environment showed a 100% increase in tooth decay. The experiment, covering an 18-month period compared the cavity rate of men living in submarines with those based on shore. Lack of fresh vegetables and other vitamin sources, was one reason postulated.

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industry countdown

Operational Army missiles . . .

are displaying a high degree of reliability, according to Brig. Gen. J. M. Colby, Deputy Commander of the Army Ordnance Missile Command. *Nike-Hercules* tests have demonstrated a better than 80% record intercept accuracy while the *Redstone* record has a reliability score of only two failures in 41 firings since Aug. 20, 1953. Most *Nike-Hercules* failures were traced to a single subassembly which is now undergoing re-design. Out of 15 troop-fired *Corporals* launched recently in New Mexico, 14 were successful, the Army reported.

Air Force *Hare* "ramjet" . . .

missile will recombine oxygen atoms scooped up at its operating altitude of approximately 60 miles, into molecular form, releasing great amounts of energy in the process. A catalytic agent will be needed to increase the rate of recombination. Preliminary studies indicate that gold is the most promising catalyst, with aluminum and/or mica receiving attention as the reactor construction material. Additional studies are being conducted to determine more precisely the concentration of the oxygen atoms existing at the missile's proposed operating altitude. Oxygen at that altitude has been broken down into individual atoms by the action of ultraviolet radiation.

NASA is forming . . .

13 new research advisory committees to provide technical counsel and a special committee on Life Sciences to advise the agency on matters connected with human factors, medical and allied problems of the manned capsule program. The committees, which are expected to start functioning early next year, "will promote communication with other workers in the same or allied fields by reviewing research in progress, considering new problems, and making recommendations regarding the direction in which future research should go."

NASA's committee . . .

will be concerned with the following fields: fluid mechanics; aircraft aerodynamics; control, guidance and navigation; chemical energy processes; nuclear energy processes; mechanical power plant systems; electrical power plant systems; structural loads; structural design; structural dynamics; materials; and aircraft operating problems.

GAM-77 *Hound Dog* missile system . . .

will move into the production picture with the award of an $18,928,000 contract to North America Aviation's Missile Division for a limited quantity of the air-to-surface bird. Initial use of GAM-77, the missile portion of WS-131B, will be with the Boeing B-52G bomber. The missile will be powered by a PW J-52 turbojet engine with 7500-lb thrust. Directed to the target by a self-contained inertial guidance system, *Hound Dog* will carry a nuclear warhead. Meanwhile, SAC has successfully launched the McDonnell *Quail* decoy missile from both the B-47 and B-52.

NAA's ion rocket test laboratory . . .

was placed in operation last week at the Propulsion Field Laboratory of Rocketdyne. Tests will begin early in January after checkout of the lab equipment. Equipped with an electrical power supply rated at 40,000 volts at two amperes, the lab will operate engines of one-tenth pound thrust with extremely high specific impulse values. Engines will be fired in a high vacuum chamber to duplicate the airlessness of space. NAA built the lab with capital funds to advance development studies initiated in 1954.

Atlantic Research . . .

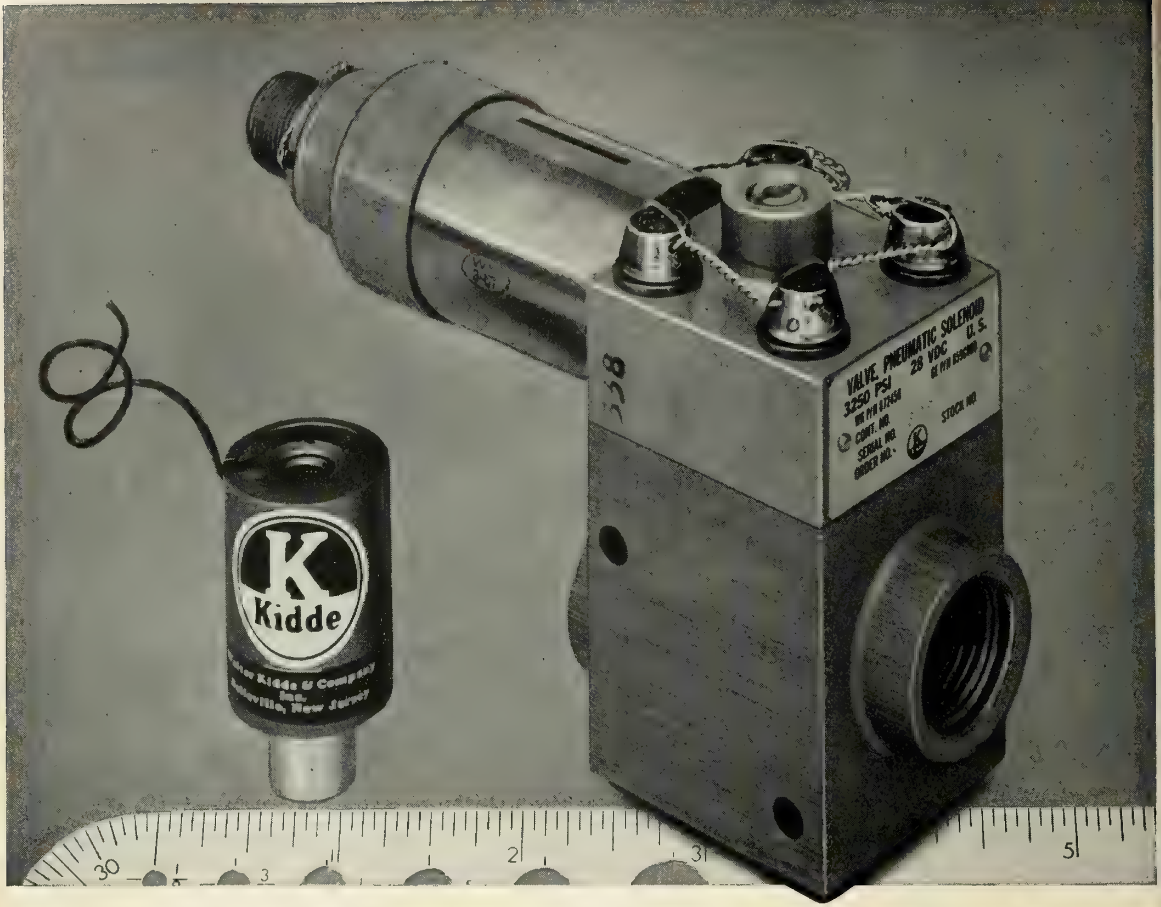
will use three of its research rockets in a *Polaris* acceleration program. The small *Arcon*, *Iris*, and *Arcas* are being called into service for studies, thus saving the current test vehicles. *Arcon* will investigate vibration problems expected to be encountered by the *Polaris* in flight. *Iris*, designed to carry 40 pounds of instruments to a height of 70 miles, is expected to be ready for flight testing early next year. *Arcas* will be used for missile research and routing weather data collection.

Competition has been reopened . . .

for the single chamber one million pound thrust engine, according to ARPA Director Roy W. Johnson. Development originally was contracted to Rocketdyne when program was under ARPA. NASA took over and reportedly has ordered a reopening to allow companies to bid—such as Pratt & Whitney—who were not in the rocket field when ARDC held the original competition.

No decision taken . . .

on a proposal before the Aircraft Industries Association in Phoenix recently for a name change. Topic will come up again at the Williamsburg Spring meeting.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DECEMBER 1, 1958
VOL. 4, NO. 22

missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

Bold Orion: AF Answer to *Polaris*

by Donald E. Perry

WASHINGTON—The Air Force has a new missile system under components test in answer to the Navy's *Polaris* concept that spells new capability for Strategic Air Command bombers.

The WS-199B, of which one version is called *Bold Orion* is under test by both Lockheed Missile Systems Division and the Baltimore Division of The Martin Company, m/r has learned exclusively.

A two-stage solid propellant, it is being designed for air-to-surface launch from existing and future SAC bombers. With a maximum range of 1,000 miles, it may be the first ballistic missile that will be controllable when reentering the atmosphere, with a choice of a primary or secondary target.

- **Aloft for days**—If placed on the U.S. atomic-powered missile launching platform, now under development, it will mean the Air Force can keep the missile aloft for many days in a readiness condition for immediate retaliation. Intermediate use of the missile would be on the Boeing B-52, the Convair B-58 and the chemically-powered North American B-70, when it becomes available.

Development of the missile reportedly is being pushed by General Thomas D. White, Air Force chief of staff, and the service can be expected to officially announce that the system is under development soon after the first successful firing of its second stage, anticipated in the near future.

Gen. Thomas D. White

General White recently said that he felt that "real promise lies in the development of long-range airborne missiles which can be launched against targets from bomber aircraft." He said their use on chemical or nuclear powered bombers could "give us a capability to maintain a constant patrol of the free world skies," and this flexible force would be virtually impossible to neutralize even with a surprise attack.

Reliable sources have informed m/r that Martin has made five successful drops of a ballistic missile from a B-47 to test first stage ignition.

Bold Orion is strikingly similar to a slimmer elongated *Bullpup*, a Martin development.

It can be assumed that the missile has a length of around 20 feet and a diameter of about two feet. It is first dropped in free fall by the mother aircraft. First stage ignition propels it forward and away from the launch plane, and it then arcs into a programmed ballistic trajectory.

A third-stage Grand Central rocket used on *Vanguard* reportedly is being used as the first stage of *Bold Orion*'s test vehicle. However, Thiokol Chemical Co. reportedly will furnish the first stage in the final configuration, and the Grand Central rocket will be used as the second stage.

The missile has four movable canards on its nose for control during reentry. Four tail fins probably are fixed for stability. The finished vehicle would carry a nuclear warhead, probably of megaton yield because launch from an altitude of about 40,000 feet will reduce fuel weight, providing a larger payload. Explosive and guidance probably will separate from second stage during reentry, providing a diversion for an enemy anti-missile missile.

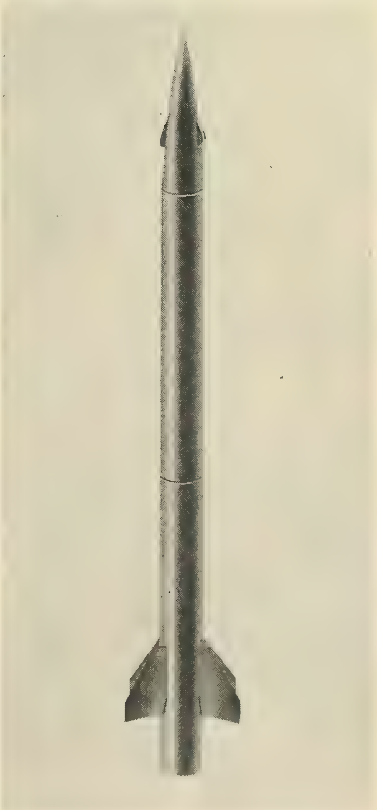
- **Probably Doppler**—Guidance is probably some sort of Doppler system. If so, this could mean a radio command link from launch to first stage cutoff, and possibly another link during second stage burning to provide necessary corrections for optimum cutoff point.

It conceivably would be command-guided from a control center—possibly in the bomb bay of the launch aircraft, until near the target at which time active or infra-red radar would take over. Guidance could also perform preprogrammed evasive action, changing from a primary to a secondary target to evade anti-missile defense. Guidance undoubtedly is an outgrowth of some of the Bell Labs work on radio-inertial systems for the *Thor* and *Titan*, or the GE work on the *Atlas* radio-inertial system.

The missile undoubtedly is the successor which Air Force has mentioned for the turbo-jet powered *Hound Dog*. *Hound Dog* with its 250/500-mile maximum range and altitude maximum of over 50,000 feet is definitely limited.

With the missile's range, it has a dual capacity of either launch before penetration or of going after targets too deeply within the enemy's homeland for limited range missiles.

The dollar-volume put into *Bold Orion*'s development to date has been small. But Air Force reportedly has assigned a high priority to its development and may be willing to commit large sums if it can be placed into production quickly.



ARTIST'S CONCEPTION of configuration of WS-199B, *Bold Orion* **missile.**

FLOURINE PROPULSION proponent John Sloop of NASA's Cleveland Research Center, confers with Fenwall's Robert Gallagher.

MAJ. GEN. H. F. TOFTOY receives James H. Wyld Memorial Award from Mrs. Wyld. Toftoy was cited for missiles development.

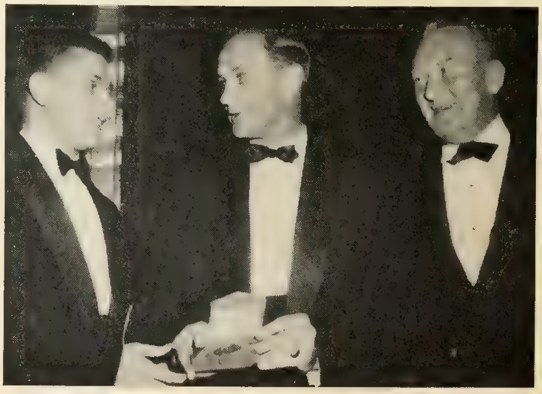
SPACE CAPSULES may be the conversation topic between AVCO's Arthur Kantrowitz and AF Brig. Gen. Don Flickinger.

ARS PAST President George Sutton . . . from a $5,000 deficit at beginning of his term, he ended the year with $50,000 profit.

Place: ARS Meeting—Subject: People

Photos by Norman L. Baker and William O. Miller

ABMA's Wernher von Braun and Captain Robert C. Truax of ARPA. At left is Dr. C. Generales, friend of von Braun.



THIOKOL AWARD was presented to F. H. Reardon of Princeton by James Gavin. H. R. Ferguson looks on.

GOODARD MEMORIAL award was presented by Mrs. Goodard to Robert B. Canright of NASA.

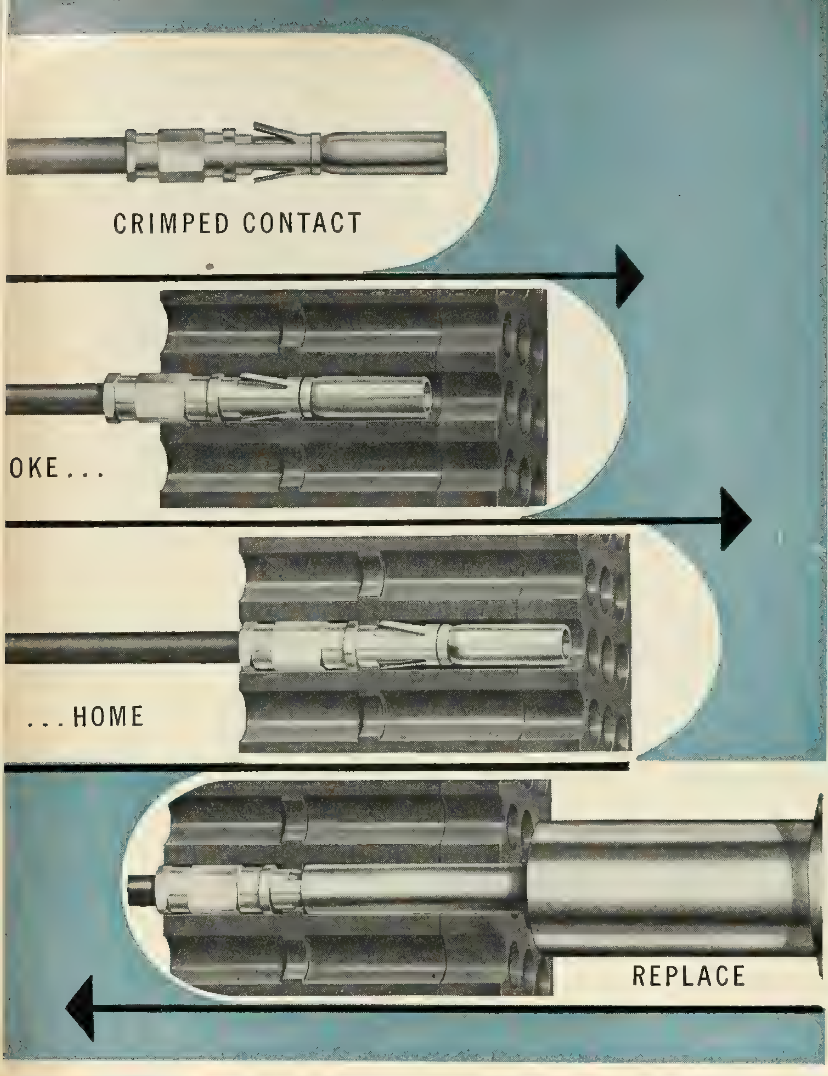
G. EDWARD PENDRAY gives Pendray Award to Homer Newell of NASA for his contribution to rocket research.

NEW ARS President John P. Stapp and m/r Editor Erik Bergaust discuss future of space flight at 13th annual meeting.

AEROJET RECEPTION was well attended. Vice-President William Gore and ARPA's Robert Truax compare notes.

ASTRONAUTICS AWARD was presented by Andrew G. Haley to Mrs. Iven Kincheloe in behalf of work of her late husband.

FINANCIER OF Goodard's work, Daniel Guggenheim and retiring ARS President George Sutton at Awards Night Banquet.



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ARS Session Devoted to Future Developments

New York—In addition to the frankly futuristic forecasts of passenger-carrying ballistic missiles, space post offices and dealings with life on other planets, several solid facts emerged from the recent annual gathering of American Rocket Society members at the Hotel Statler in New York:

From Roy Johnson, Director of ARPA:

That for successful anti-missile defense we need to know much more about reentry physics and how a reentering body looks; how to use tools other than radar for warning and tracking; and more about the effects of nuclear weapons against nuclear weapon.

That ARPA has started a $100 million basic research program on anti-ICBM by tracking our own missiles at Cape Canaveral with $60 million in contracts already let.

That for the next several years the U.S. will depend upon *Thor, Jupiter, Atlas* and *Titan* boosters; that coupled with these ARPA has authorized the contract for development of a high liquid energy fuel upper stage (30,000 to 75,000 lbs thrust) to achieve useful satellite payloads weighing up to four and five tons.

That the order given in September for the clustered engine to develop possibly one and a half million pounds thrust is being designed to use an *Atlas* or *Titan* as second stage; is expected to be test fired in the summer with launch in 1960. Object: 25,000 pound payload on moon.

That ARPA is looking toward a cluster of four or five million-pound thrust engines for space stations within the next 6-7 years.

From Lt. Gen. James M. Gavin (Ret.):

That there are many new technological developments in the missile industry which can be used with profit in industry. For example: translating plasma technology into thermal industrial processes; a reliable flow meter, first developed for measuring liquefied gases, which has no packings or bearings; an entire new family of plastics; heat-dissipating electrical coils; more accurate measuring devices for surveyors; jet drilling devices; and multiple industry uses of infrared.

From NASA Deputy Hugh Dryden:

That the proposed transfer of Huntsville Army technicians to NASA is still under discussion; that NASA expects to use ABMA talents no matter how the decision goes; that the trend is toward sealed space cabins and away from space suits.

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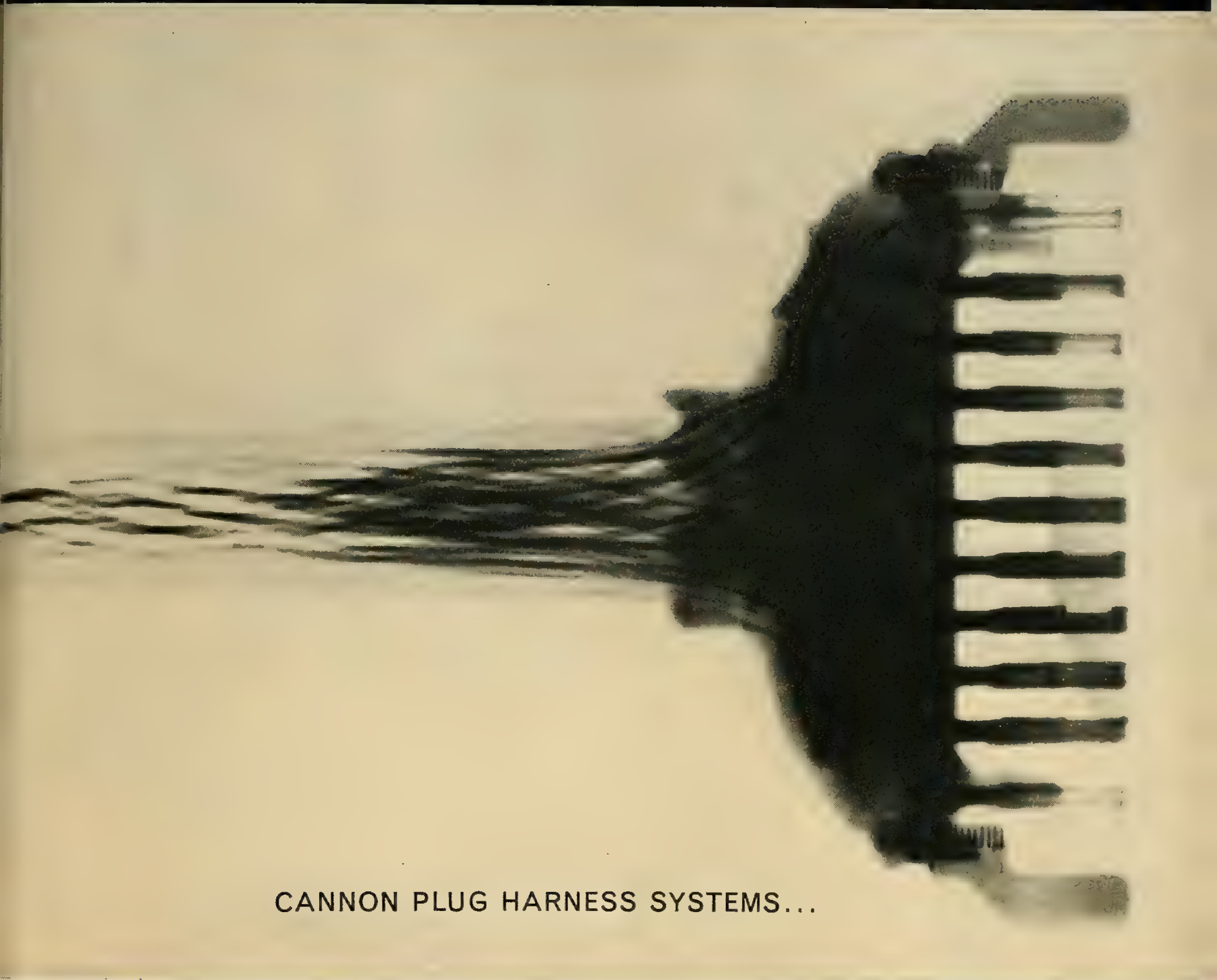

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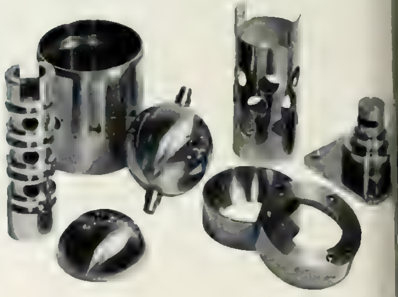

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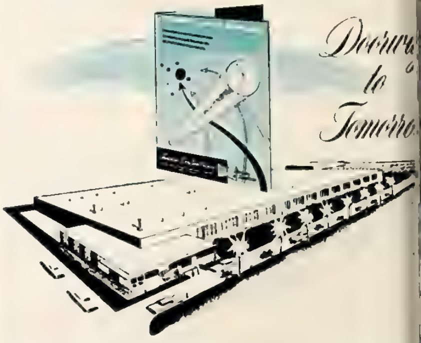

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Papers Presented At This Year's ARS Meeting

Here are brief abstracts of technical papers presented at this year's American Rocket Society meeting in New York, November 17-21. This magazine is grateful to the American Rocket Society and the authors. Reprints of these worthwhile papers may be ordered through ARS, 500 Fifth Avenue, New York 36, N.Y.

A Rational Approach to High Performance Rocket Injector Design, I. J. Weisenberg, (674-58) Concludes that "The Kinetic approach to high performance injector design is the most desirable but is inhibited by the present state-of-the-art."

The Vaporization of Propellants in Rocket Engines, Richard J. Priem & Marcus F. Heidman, (675-58).

Vaporization Rate Limited Combustion in Bipropellant Rocket Chambers, E. Mayer, (676-58).

A Study of Combustible Mixture Formation With Liquid Fuels, Glendon Benson, M. M. El-Wakil, P. S. Myers, O. A. Uyehara, (677-58).

Psychophysiological Aspects of the Man High Experiment, Lt. Col. David G. Simons, (678-58).

Application of a New Technique for Recording Skin Resistance Changes, E. Z. Levy, G. E. Ruff, V. H. Thaler, (679-58). A summary of recent research at Aero Medical Laboratory, WADC, on measurement of skin resistance to determine fatigue.

Modifiability of Day-Night Cycling, George T. Hauty, (680-58). Deals with recycling human activity to increase efficiency as part of man-machine system.

Psychophysiological Aspects of a Multiple Crew Compartment Study, Capt. C. F. Gell (681-58). Concludes that men with good morale, discipline, training and motivation can tolerate long periods of confinement such as might be encountered in spaceflight.

Current Studies at Walter Reed, Lt. Col. Paul B. Yessler, (682-58). Deals with studies on sleep deprivation, experimentally-conditioned behavior in animals and some aspects of the neuroendocrinological response to stress.

The Measurement of Human Adaptation to Stress, Sanford I. Cohen, A. J. Silverman, B. Shmavonian, (683-58).

The Electroencephalogram as a State-of-Consciousness Indicator Under Balloon Flight Conditions, Neil Burch, (685-58).

Combustion Research—Whence and Whither, John B. Fenn, (686-58).

Correlation and Prediction of Flame Properties, Melvin Gerstein, (687-58).

Recent Advances in Gaseous Detonation, Robert A. Gross, (688-58).

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Nuclear Rocket Propulsion Program at Los Alamos, Raemer E. Scheiber, (689-58).

Some Boundary Conditions for the Use of Nuclear Energy in Rocket Propulsion, Robert W. Bussard, (690-58). Concludes that "Propellant specific impulse should be greater than 1000 sec but need not exceed 3000 sec for a useful payload capacity for most missions within the solar system."

Optimum Thrust Programming of Nuclear Rockets, Chiao J. Wang, Herbert R. Lawrence, George W. Anthony, (691-58). For a nuclear rocket of variable specific impulse, there is an optimum way of programming the thrust for a mission.

Design Considerations for Nuclear Rocket Test Stands, Sidney G. Rumbold, (692-58).

Dynamic Analysis of a Nuclear Rocket Engine System, Bernard R. Felix, (693-58).

Navy Interests in Sealed Cabins, Malcolm D. Ross, (694-58).

Sealed Cabins for Life Satellites, Lt. Col. David G. Simons & Capt. Eli L. Bleeding, (695-58).

Sealed Cabins: Advanced Research Projects Agency Views, Richard D. Holbrook, (696-58).

Sealed Cabin Requirements for Non-Military Missions, Max M. Faget & C. W. Mathews, (697-58).

Sealed Cabins: Area of Indecision, Irwin Cooper, (698-58).

Climatic and Structural Aspects of Sealed Cabins, F. L. Dickey and G. H. Knipp, (699-58). Considers advantages to the crew of an optimum internal atmosphere and pressure and the effects on a sealed cabin structure.

Accelerations of Space Flight, Col. John P. Stapp, (700-58). States that accelerations inherent in present 3-stage rocket systems are tolerable by man and could conceivably be used for manned space flight.

Sealed Cabins: Research Program, Otto Winzen.

Space Cabin Requirements as Seen by Subjects in the Space Cabin Simulator, Capt. Willard R. Hawkins, (702-58).

Psychological Aspects of Sealed Cabins, Arnold Small, (703-58).

Biothermal Aspects of Re-entry from Extra Atmosphere Flight, Earl T. Carter & M. W. Jack Bell, (704-58). Points out certain biothermal problems expected to arise during re-entry of a manned vehicle.

Air Turborocket Developments, William N. Gilmer.

External Burning Ramjets, Gordon L. Dugger, Louis Monchick & R. H.

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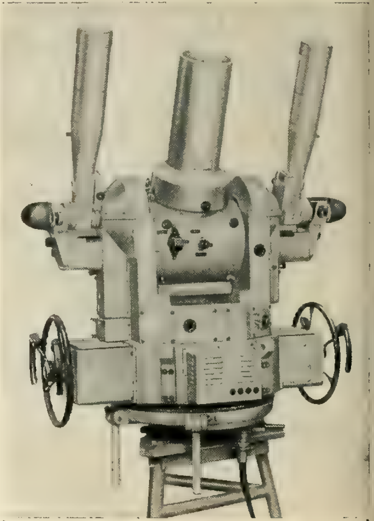

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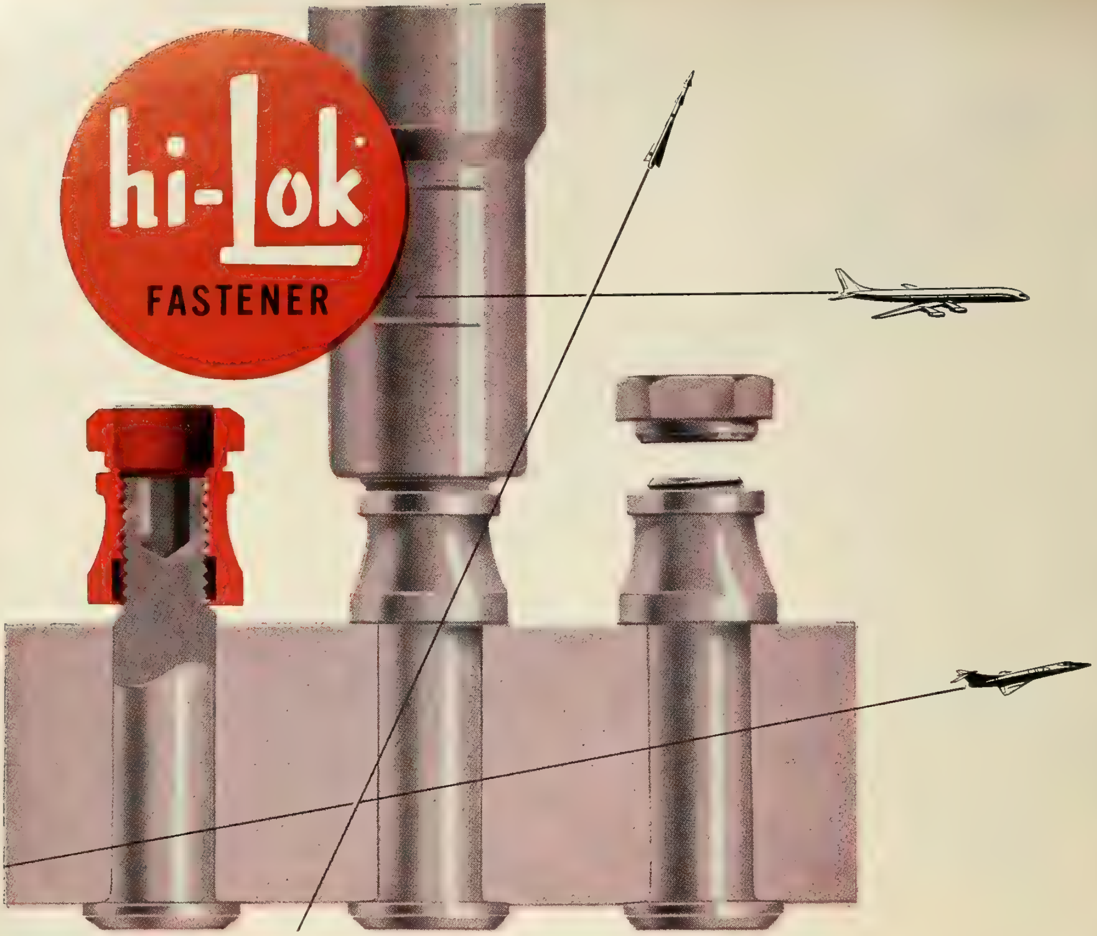

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Cramer.

Solid Fuel Ramjet Developments, H. Powell Jenkins, Jr.

General Behavior of Hydromagnetic Fluids, Russell M. Kulsrud, (705-58).

Aerothermodynamic and Electrical Properties of Some Gas Mixtures to Mach 20, W. Chinitz, L. Eisen, R. Gross, (706-58).

Experimental Magneto-Aerodynamics, Richard W. Zeimer, (707-58), Draws several conclusions, including the fact that experimental data for the stand-off distance ratio agree with theoretical predictions.

Preliminary Studies on Electrical Propulsion Systems for Space Travel, Robert Fox, (708-58). States that the problems in this field do not appear to be greater than those associated with development of modern high performance jet and rocket engines.

Magnetohydrodynamics in Aeronautics, W. R. Sears, (709-58). Notes that future applications may have to wait for new developments in other fields, such as lightweight fission or fusion power sources.

Commercial Rocket Airplane: A Connecting Link to Manned Space Flight, Robert A. Cornog, (710-58).

The Geodetic Satellite, Robert P. Haviland, (711-58). Discusses uses of satellites for increasing knowledge of the earth, its shape, gravity field, etc.

The Orbital Post Office, Sidney Metzger, (712-58).

Space Law: Recent Practical Achievements, Andrew G. Haley, (714-58).

A Preliminary Experiment with Recoverable Biological Payloads in Ballistic Rockets—Project MIA, F. L. van der Wal and W. D. Young, (715-58). Disucsses the Thor-Able program which launched mice into space.

Lockheed X-17 Test Vehicle and Its Applications, Ronald Smelt, (716-58).

Far Side Rocket Research Program, Herbert L. Karsch, (717-58). Discusses the program which developed an important technique in less than one year for less than one million dollars.

Explorer Rocket Research Program, Geoffry Robillard, (718-58).

Vanguard Research Rocket Program, Milton Rosen, (719-58).

NASA Research Rocket Program, A. O. Tischler, (720-58).

Reduction of Flight Time and Propellant Requirements of Satellites with Electric Propulsion by the Use of Stored Electrical Energy, Morton Camac, (721-58).

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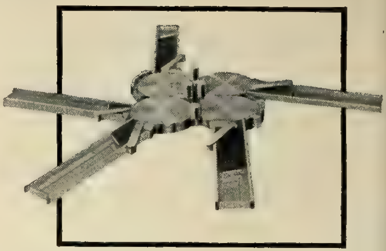

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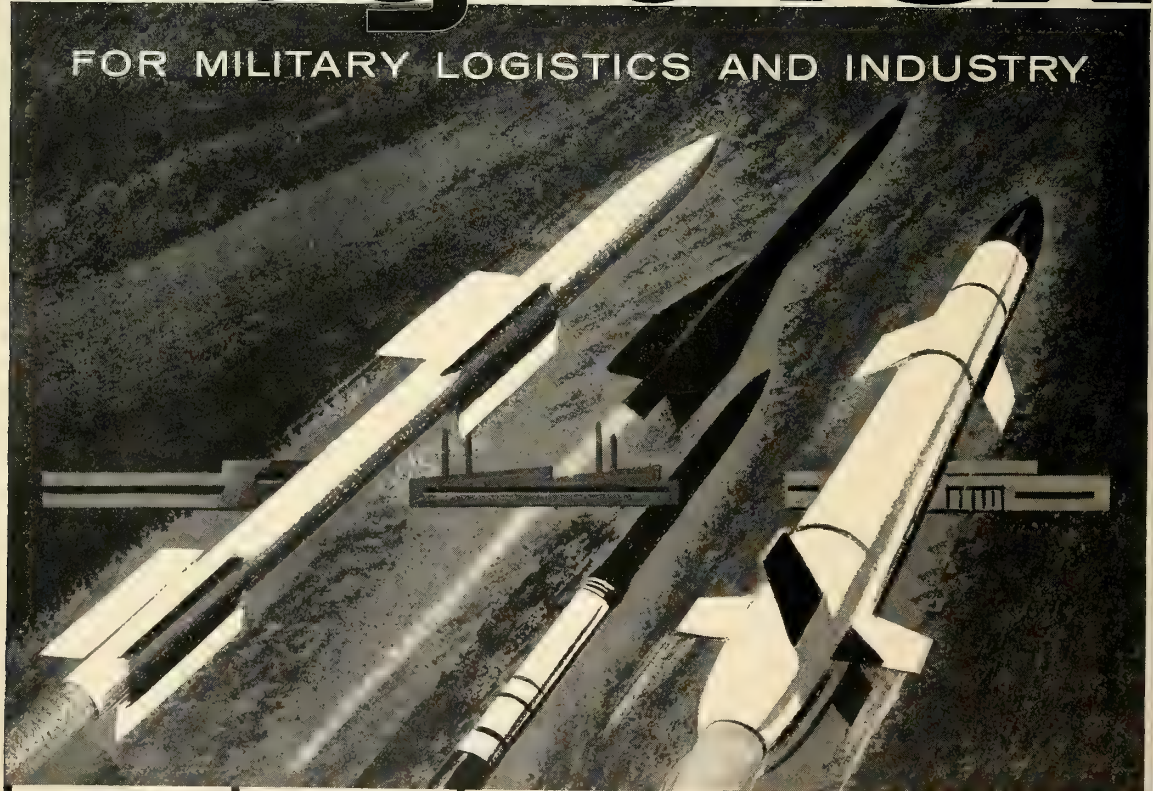
FOR MILITARY LOGISTICS AND INDUSTRY

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of Satellite Attitude Motions, Robert Roberson, (722-58).

Composite Trajectories Yielding Maximum Coasting Apogee Velocity, Stanley Ross, (723-58).

Electric Arc Gas Heaters for Re-Entry Simulation and Space Propulsion, Thomas R. Brogan, (724-58). Describes the development and calibration of an arc-powered wind tunnel designed to provide steady flow simulation of the conditions encountered during re-entry.

Missile Control Systems, D. T. Sigley, W. Hostetler & E. W. Ford, (725-58).

An Approach to Predetermination of Reliability, P. F. Winternitz & L. V. Toralballa, (726-58).

A Servo System for an Air Bearing Gyro Stabilized Platform, R. C. Martin, (727-58).

Matching Auxiliary Power Supplies with Missile Control Requirements, H. J. Howard, (728-58). Discusses means of selecting an auxiliary power supply best fitting needs of a typical missile control system.

Some Structural Aspects of Orbital Flight, George Gerard, (729-58).

Brazed Sandwich Structures for Missiles and Space Vehicles, Richard S. Mueller & George D. Cremer, (730-58). Purpose is to apprise today's capabilities in the field of braze joining, with emphasis on high-temperature, corrosion-resistant brazing applications.

Buckling of Unstiffened Thin-Walled Cylindrical Shells Subjected to Various Loading Conditions with and without Internal Pressure, Bertram Klein, (731-58). Reliable and simple design curves are presented for determining the allowable buckling stresses of the subject structures.

Structural Considerations of Manned Space Vehicles, Anthony P. Coppa, (732-58). Gives approaches leading to an optimum vehicle, considering the requirements of thermodynamic and human factors, in addition to structures.

Structures for Space Craft, Paul E. Sandorff, (733-58).

Contour Nozzles, Ellis M. Landsbaum, (734-58).

General Technical Report on the Experimental Liquid-Propelled Rocket, The DREX-3, Charles R. Meldum, (739-58). Analyzes mechanical operation and component structure of the experimental rocket built at the University of Detroit.

Inertial Guidance, Bert W. Hilburger, (741-58). Consists of a brief resumé of the subject, as it exists today.

This is one of a series of professionally informative messages on RCA Moorestown and the Ballistic Missile Early Warning System.

BMEWS AND THE PROJECT ENGINEER

Time, money and the achievement of performance specifications are the three dimensions in the world of the Project Engineer. Scheduling, cost control and technical accountability . . . these are grave responsibilities on any engineering program involving the national security. On BMEWS, with its objective of early warning against enemy missile attack, they comprise the most sensitive of engineering assignments, anywhere.

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Industry is pioneering new methods to form better steel alloys in casings to advance solid propellant missiles beyond present state of the art.

Motor Development Depends on Alloys

by Norman L. Baker

WASHINGTON—The rate of advancement of U.S. large solid propellant ballistic missiles is currently controlled by the state of the art in motor materials development. This control will continue to exist until major improvements have been made in materials, motor unit design, and fabricating techniques.

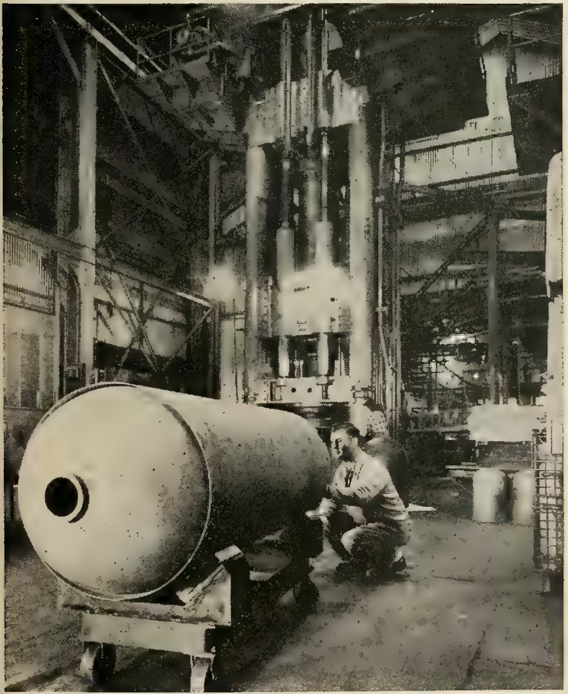
Basically the problem is one of improving the quality of current steel alloys and finding new and better methods of forming and fabricating. In the past, such problems were the responsibility of our large steel industry. But here is where the real problem begins. The tonnage of steel currently required for the nation's entire missile program apparently is too small to secure the sincere research interests of the steel industry. Therefore, responsibility has been placed on the smaller metal working firms, many with years of experience in light-walled high pressure vessels.

- **Large grain development**—For example, Thiokol Chemical Corp., for many months has been engaged in a development program directed toward achieving motor chamber designs of the lightest possible weights for the *Minuteman, Pershing* and *Polaris* weapons systems. Thiokol has called upon several organizations that have in the past contributed greatly to the current state of the art in case manufacture. Some of these companies are:

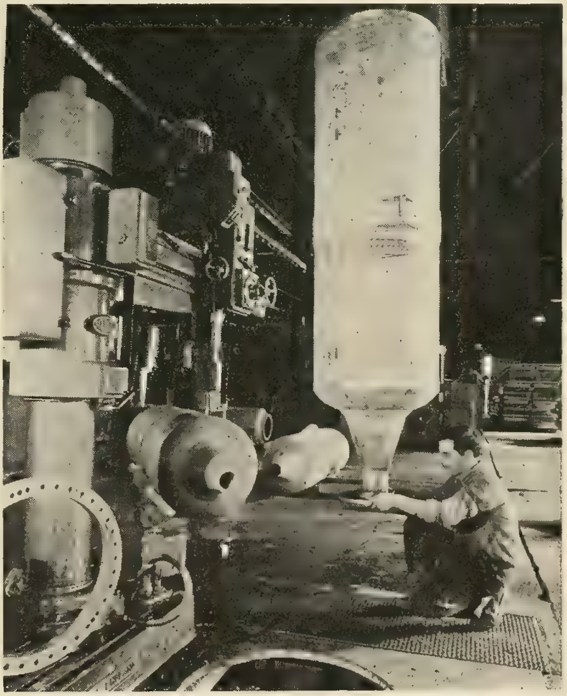
1) Borg Warner Corp., Ingersoll-Kalamazoo Division
2) M. W. Kellogg Co.
3) Excelco Developments, Inc.
4) Jet Division, Thompson Products, Inc.
5) Diversey Engineering Co.
6) Scaife Co.
7) Curtiss-Wright
8) Solar Aircraft

During this development program large diameter motor cases of 28, 31, 54, 60, 62, and 70 inches have been rigorously analyzed. Surveys of existing materials have disclosed that steel, formulated specifically for high yield strength casings is not readily available. It was found that hot-work-die steels closely approximate the properties and requirements but demand highly refined techniques of metal manufacturing and fabrication.

Recent developments indicate a successful solution to the fabrication problem on a small scale, although a major effort will be needed before these techniques can be incorporated into a practical and reliable production



COMPLETED SOLID PROPELLANT motor case for the *Nike-Hercules* sustainer at the Scaife Co. plant. In background is 1500-tone hydraulic press for deep-drawing.



FORWARD THRUST ATTACHMENT of *Matador* TM-76 booster is jigged for insertion into the fixture in special drill pit. Fixture assures proper bolt alignment.

NOTABLE ACHIEVEMENTS AT JPL . . .

PIONEERS IN MOBILE MISSILE SYSTEMS

The "Sergeant's" excellent mobility characteristics, including the ability to operate under conditions of winter snow, ice, mud, desert sand and heat, significantly extend the capabilities of the system for close support of a ground command in our modern United States Army. The ease of operation and handling permits the weapon to be unloaded from airplanes or landing craft and be ready for firing with a minimum of preparation.

The system concept demonstrated in the "Sergeant" has permitted excellent mobility and speed of operation to be attained. The requirements of the Army have been stressed, resulting in outstanding characteristics of the weapon meriting the title of "America's first truly 'second generation' surface-to-surface tactical missile."

The responsibility for accomplishing this important achievement has been placed on JPL by the United States Army Ordnance Missile Command.

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method.

Several methods of fabrication are being investigated. Each method has required a materials evaluation program to select the steel that can be most efficiently adapted to the method of fabrication. The most promising methods are roll-and-weld, deep-draw, power-spin, helical-weld, vacuum-weld and strip or ribbon spiral-wrap.

One of the firms working under Thiokol subcontract that has been selected to conduct further development efforts on a concurrent basis is the Scaife Co. of Oakmont, Penna.

Scaife, a pioneer in the development of deep-drawn motor cases, has maintained a multiple metal working fellowship at the Mellon Institute in Pittsburgh, assuring an unusual and highly competitive position in the field of advanced metal parts processing and development techniques. It was recently reported (m/r, Nov. 17, p. 9) that Mellon Institute had fabricated rocket motor cases that were tested to a yield strength of over 225,000 psi. The Air Force and Navy are asking for *Minuteman* and *Polaris* motor cases with yield strengths from 210,000 to 240,000 psi.

- **Material requirements**—Current missiles have solid propellant motor cases fabricated from steels comparable to AISI-4100 to yield strengths up to 160,000 psi. The larger casings for the *Minuteman* and *Polaris* have demanded a great reduction in the weight of the casing wall and metal parts (nozzle, heads, rings, etc.). This requirement has made it mandatory that high strength steels such as AISI-4340 or H-11 hot work tool steels be incorporated as motor material.

Experience with the production of *Hawk, Nike-Hercules,* and *Matador* motor cases has enabled Scaife to participate in the current development of the large grain motor bodies for IRBMs and ICBMs. The production of the smaller motor cases required the use of deep-draw, hot and cold spinning, hot extrusion, cold sizing, automatic and semi-automatic inert shielded arc welding and heat treating to strength levels in excess of 200,000 psi. The same techniques were employed in the construction of motor cases and other components of the *Polaris-B* missile system. This case was 38 inches in diameter.

Scaife is currently engaged in the development of wall motor cases for an operational long range solid propellant ballistic missile. The program is employing the techniques of deep-draw and helical weld while a parallel program is employing the helical welded case construction.

The deep-draw program involves the evaluation and development of suitable high strength materials, specifications for the materials, and the establishment of forming techniques for the side walls, head, and aft end. The

DEEP-DRAWN ***Falcon*** **motor case being oil-quenched before heat treating operation.**

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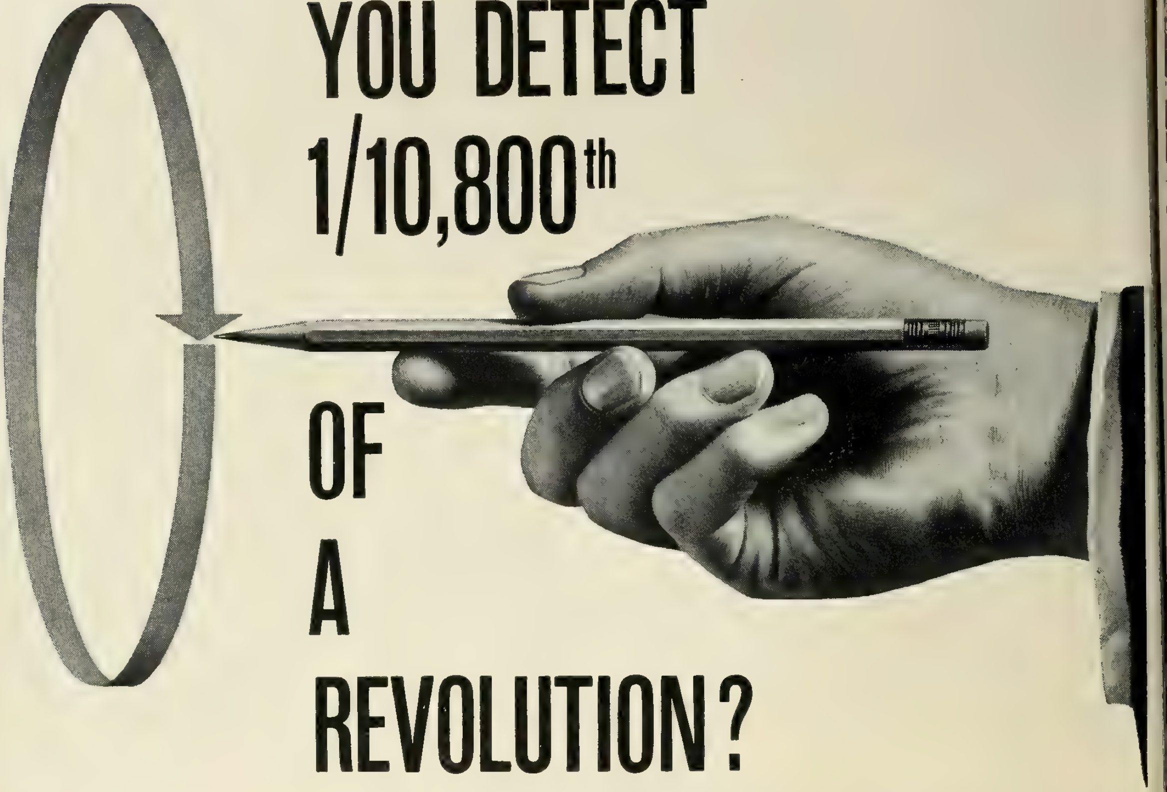

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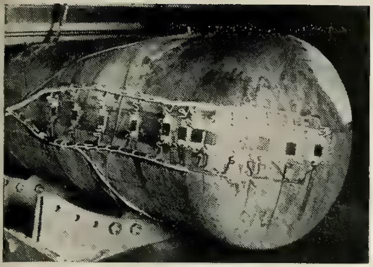

TESTING of high-yield strength deep-drawn motor case using strain gauges.

assembly of these components by a welding operation has received a parallel development effort.

Scaife, with present machinery, can deep draw cases up to 56 inches in diameter and 42 inches in length. The dimensions can be exceeded by modification of the existing machinery according to company officials. If the diameter does not exceed 56 inches, length of the motor units can be increased simply by butt-welding the drawn cylinders.

- **Deep-draw technique**—In the deep-draw process, a circular sheet of metal is pressed and drawn into a seamless cylindrical cup with the side wall thickness held to within a very few thousands. Two of the cups are then machined to the desired length and butt-welded. If a greater length—than can be obtained with two cups—is required, the spherical end of as many cups as needed is trimmed off and the open tube is welded into place. The joined case is then heat treated to the desired strength level.

The assembly is again machined and certain non-pressure components are attached. The completed unit is given a special treatment to protect it against hydrogen-embrittlement after the final machining. During testing, strain gauges are attached to various sections of the case to determine the magnitude and distribution of stresses. Finally, the case is subjected to a hydrostatic test.

Although the large (1500 and 750 ton) hydraulic deep-draw presses are the most outstanding pieces of equipment in Scaife's manufacturing facilities, the rest of the production layout reflects a highly specialized and diversified production capability. Equipment includes blanking and forming presses; planers, lathes, milling and other machine tools; shot and sandblast; pickling and cleaning; welding; heat treating; and forging and extrusion equipment.

Six categories of research are also carried on by Scaife.

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Background should qualify for planning and formulating entire flight test programs.

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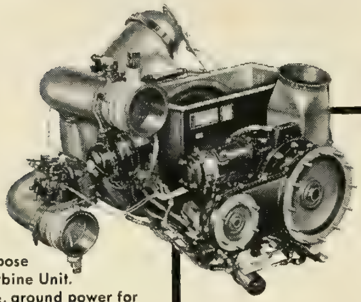

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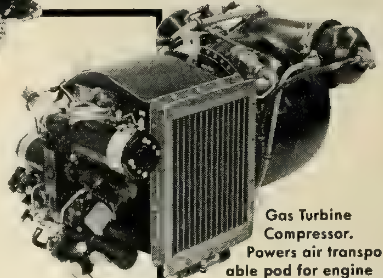

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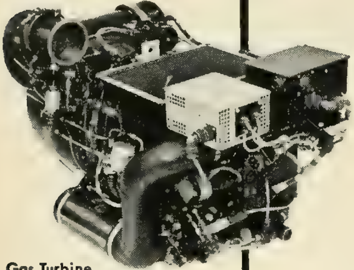

Gas Turbine Compressor. Standby in-flight pneumatic power for turbine-powered transports.

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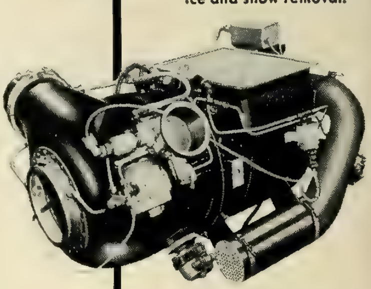
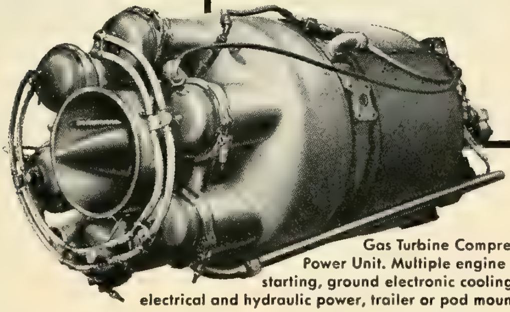
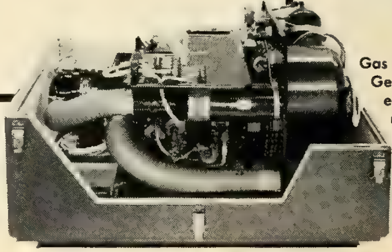


Gas Turbine Compressor Power Unit. Electrical and pneumatic ground power source for jet transports.



Gas Turbine Compressor Power Unit. Multiple engine starting, ground electronic cooling, electrical and hydraulic power, trailer or pod mounted.



Gas Turbine Generator Set. Primary electrical power for missile launchers, guidance and refrigeration systems.

AiResearch Gas Turbines are used in hundreds of applications: auxiliary power and ground support for missile systems, military and commercial aircraft; main engine starting, electrical and pneumatic power, air conditioning, pressurization, pre-flight check-out, snow and ice removal; prime power for helicopters; variety of ground applications or aboard aircraft for mobile or stationary use.

Advantages: these lightweight units are air transportable as fixed installations, detachable pods or portable vehicles; supply low pressure air and shaft power from 30 H.P. to 850 H.P.; provide variety of electrical power—9 to 150 KW, 60, 400 and 1200 CPS, AC or DC; have highly refined self-regulating controls and operate in any weather; have instant push-button starting; time between overhauls 1000 hours or 3000 starts.

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Circle No. 43 on Subscriber Service Card.

New Concept In Data Handling Equipment

Telemetering units developed by Applied Science Corp. analyze data before transmission to ground equipment.

by Raymond M. Nolan

PRINCETON, N. J. — Telemetering equipment employing a new and advanced concept of statistical data handling has been developed by the Applied Science Corporation of Princeton (ASCOP).

The new equipment promises more efficient handling of data on missile and aircraft performance by statistically analyzing the data and extracting its significant information content for transmission, recording and analysis.

Principal advantages offered are conservation of telemetering bandwidth, reduction in the weight-to-data ratio of airborne equipment and a marked decrease in data reduction and processing time.

The first units of this statistical data handling line are small, light, solid state airborne devices for analyzing high-frequency (vibration-produced) random data.

Since the outputs of the devices are essentially low frequency, slowly varying information content in standard IRIG D.C. signal form, the analyzed data can be transmitted by any standard telemetry system, such as PWM/FM or PAM/FM/FM etc., with resulting saving of bandwidth.

In addition, the new statistical devices save weight by reducing the required number of high-frequency, multi-transmitter installations in an airborne vehicle. Data reaches the ground in pre-analyzed, meaningful form. In many cases, no further computation or processing is necessary.

The three airborne devices are:

Airborne Spectrum Analyzer—Transistorized models weigh less than 7 ounces and occupy less than 25 cubic inches. The analyzer will accept 5-volt peak random time-history signals covering the band from 1 to 10,000 cps. and convert them into an output X-Y plot where the X-coordinate is proportional to the frequency and the Y-coordinate is proportional to power.

The output is a standard IRIG 0-5V. The analyzer is a swept type where a narrow bandpass filter is used to divide the frequency bandwidth of the input signal into equal intervals.

Amplitude Probability Analyzer—Fully transistorized models of this analyzer occupy only 20 cubic inches. The analyzer will handle random signal inputs with an amplitude range of –2.5V to 2.5V and a frequency range of 5 cps. to 25 kc. It provides an output of amplitude plotted against the probability that a given amplitude will appear in the random signal.

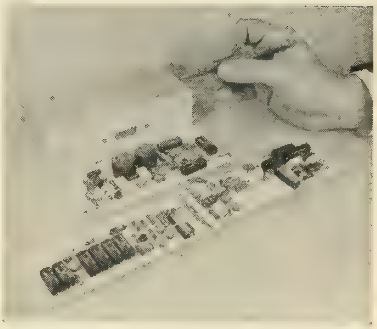
The output is in the form of standard IRIG 0-5V. The analyzer is basically a swept type which sweeps an "aperture" across the signal amplitude and analyzes the amplitude content at each level.

Time-of-Occurrence-Marker—The marker weighs 3 ounces and occupies 3 cubic inches. Although the marker is not in itself a statistical analyzer, it is an important member of the statistical data handling line because of its ability to accurately pinpoint occurrences such as transient phenomena, exceeding of limits etc.

The marker maintains an output signal of 5V minimum until it is actuated by a switch closure, transient, exceeding of limits etc. Then the output becomes a highly linear ramp function that starts from 0V at the instant the event occurs and rises back to the 5V minimum. By inspection of the ramp, the instant at which an event occurred can be determined with great accuracy.

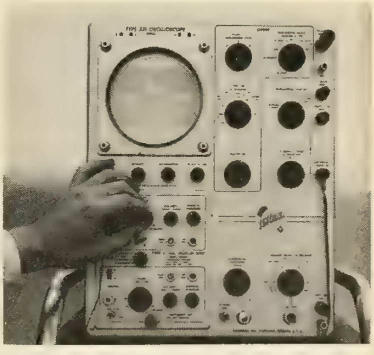
ASCOP has also developed a larger, ground-based statistical unit which is known as a Transfer Function Computer.

Transfer Function Computer—The computer is a valuable tool



COMBINED SPECTRUM and amplitude probability analyzer, part of equipment.

TIME-OF-OCCURRENCE marker used with Statistical Data Handling Equipment.



SCOPE SHOWS output of spectrum analyzer, power vs. frequency, 4-second sweep.

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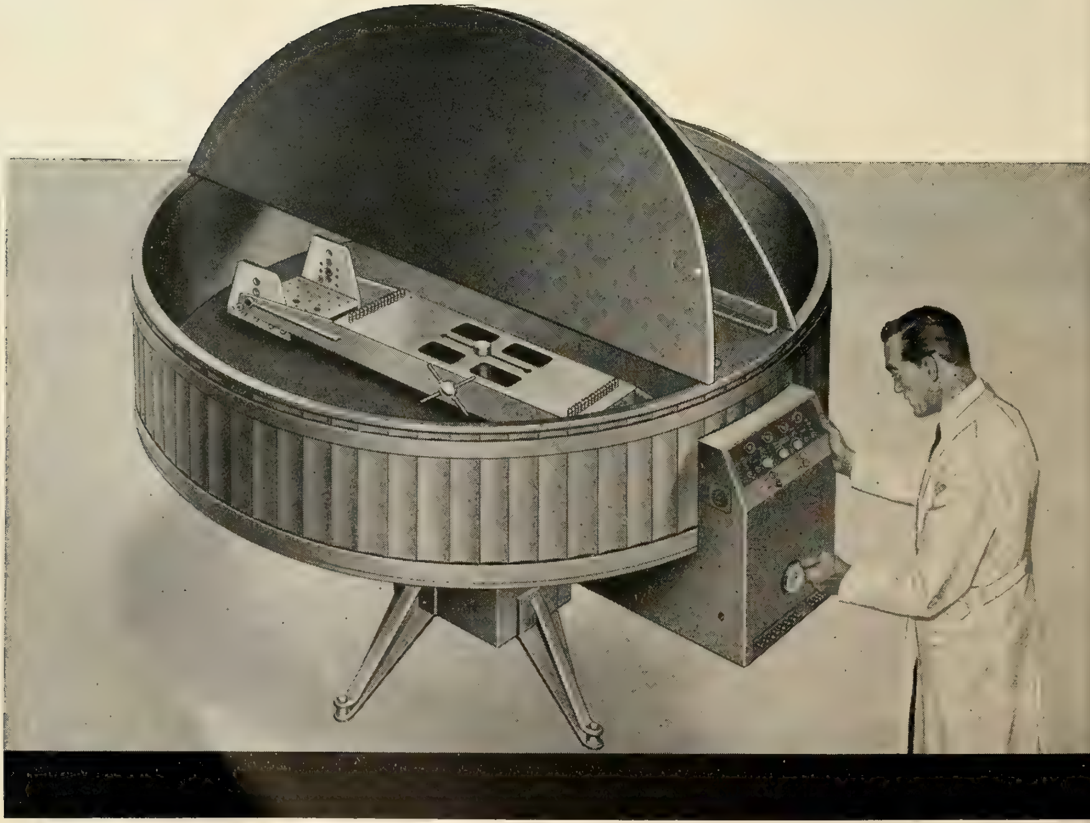

The low-cost answer to fast, accurate testing of components under simulated operational g-forces as required by MIL-E-5272A.

These new precision centrifuges feature a unique, high-torque ball-disc integrator drive system which provides accuracies you would expect only from a rate-of-turn table. Constancy of boom rotation, including wow and long-term drift, is better than .05% at any speed setting—approximately 10 times more accurate than currently available machines. Boom speed is infinitely variable and is measured by an electronic counter built into the console.

The building block design concept gives the new centrifuges exceptional flexibility. Machines are assembled from six basic off-the-shelf components; drive system, drive motor, boom, test compartment, console and accessories. You simply select components which provide features needed to meet your specific requirements. Interchangeability of the components permits easy modification as requirements change. Kits are available for modification by the customer.

This new design concept also results in manufacturing economies which are reflected in the cost of the machines. *The new machines are the lowest priced centrifuges now available—in spite of their greater accuracy, flexibility and capacity.* Ask your Genisco representative for complete information today.

There are more than 400 Genisco centrifuges now in operation.

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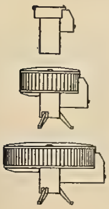
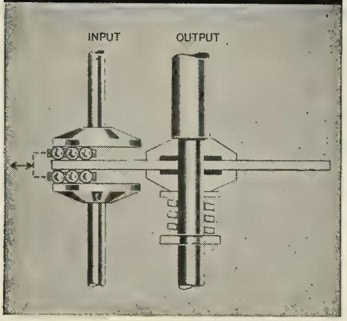
brief performance specifications



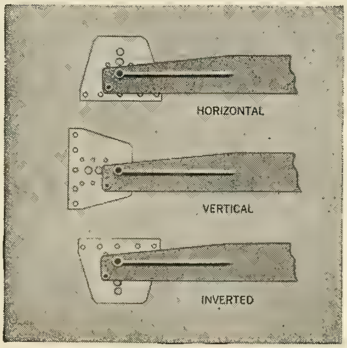
Model No.	Diameter	Test Object Weight	Capacity G-pounds	RPM Max.	G-Range Max.	Test Object Dimensions
A-1010	30" table	50 lbs. dead weight	2,500	800	.1 to 200 g's	
A-1020	60" arm	100 lb. dead weight	10,000	600	.1 to 250 g's	12" cube
A-1030	96" arm	100 lb. dead weight	10,000	400	.1 to 175 g's	18" cube

Large custom centrifuges: Genisco centrifuge experience includes the design, manufacture and installation of large custom-built machines. We invite your inquiry.



Entirely new, more efficient drive system—An integral variable speed transmission based on the new *Rouverol* *ball-galaxy principle achieves, for the first time in rotating machinery, high torque characteristics while maintaining the inherent accuracies of a hardened steel-to-steel ball-disc integrator. A novel choice of geometry among the drive elements results in a virtually linear handwheel vs rpm relationship, thus facilitating the presetting, programming and servo-controlling of output speeds. A built-in torque-limiter clutch protects the transmission from damage resulting from abuse or high inertia conditions.

*Pat. Pending



Basket-type mounting platforms, available on Model A-1020 and A-1030, may be oriented from the horizontal to the vertical or to the inverted attitude for multiple-axis testing without demounting the test object. Baskets may be raised or lowered to achieve an optimum dynamic balance and minimum angular deflections when extreme accuracies are required. When the basket is inverted the outside surface of the platform may be used to mount bulky, lightweight packages.

Available accessories include additional slip rings, servo control, microwave joints, high pressure air and hydraulic systems, TV viewing systems. Any accessory can be added *at any time* by the user. The mounting base is standard equipment.

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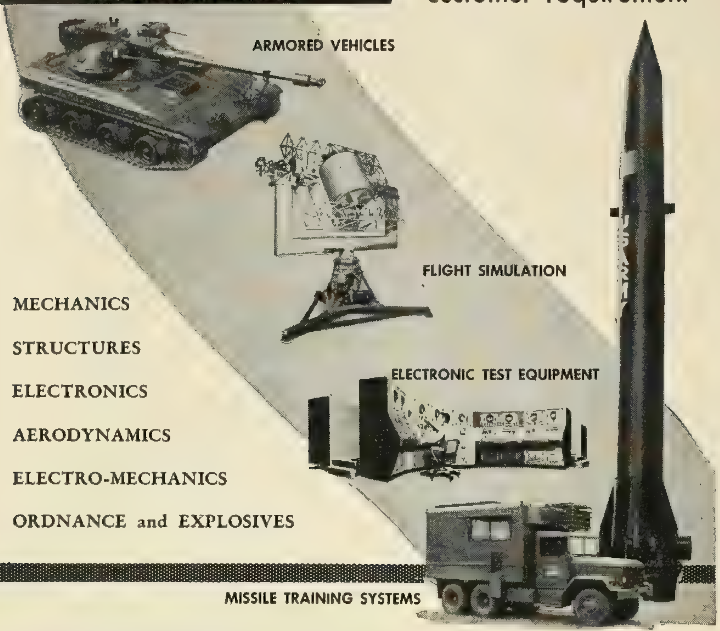

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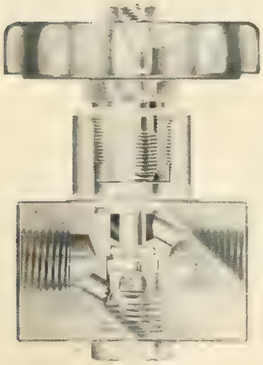

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for determining the relationship between random noise-like input and output signals, such as the exact roles different phenomena play in affecting the final vibration of a missile or aircraft member. Various packaging arrangements are available, including standard rack and chassis construction.

The computer will handle noise-like signals containing frequency components from 0.1 cps, to 15 KC at a normal input voltage of 1V RMS. Its three identical spectrum analyzers and analog computer circuitry produce an amplitude and phase relationship between the two signals under analysis for all frequencies of interest. This can be plotted in several ways. For example, an X-Y plotter can generate a family of vectors, with one vector for each frequency of measurement. The resulting graph shows the amplitude and phase of the vectors.

The first pre-production units of the airborne devices are scheduled for delivery to customers in January, 1959.

The ASCOP development program is based on the fact that most high frequency data encountered in missiles is of the random nature. As such, it can be analyzed to give low frequency, slowly varying results, such as power frequency spectra, amplitude-probability distribution and correlations between various functions.

These are the same results which are now sought by time-consuming, costly analysis and computation of time-history plots transmitted to the ground, at a high cost of airborne transmission equipment and valuable bandwidth.

Other statistical data-handling devices, including a cross correlation computer, are currently under development. The ASCOP statistical data handling program has been backed by contract support from three leading military missile agencies.

Fairchild Semiconductor Corp. Expands R&D

PALO ALTO, CALIFORNIA—Fairchild Semiconductor Corp. announced construction of a new 65,000 square foot plant facility in nearby Mountain View to provide expanded space for production research and projects in new semiconductor materials and parametric amplification.

Occupancy of the new million dollar manufacturing plant is planned for May 1, at which time the present 20,000 square foot facility at Palo Alto will be devoted to expanded research expected to result in greatly improved performance in long range surveillance radar, transmitters for space vehicles and very high speed electronic computers.

According to Dr. Robert Noyce, director of research, new materials being explored for possible use include the intermetallic compounds.

"Because of the variety of properties of these materials that may be tailored to a specific application, they have promise of extending the range of applicability of transistors to higher temperatures and higher frequencies as well as introducing semi-conductor devices operating on new principles," he stated.

"Parametric amplifiers using semiconductor diodes have given low noise performance at microwave frequencies, and, as a result are expected to find wide applicability in radar and communications," Dr. Noyce added.

Until completion of the new plant, production of present products is being handled at Palo Alto. By the end of 1959, Fairchild Semiconductor expects to have a total of 650 employees.

Camera Pick-up Tube "Heart" of New Telescope

The heart of a new opto-electronic telescope, developed by the U.S. Air Force, is a new camera pick-up tube, perfected by the Westinghouse Electric Corporation's electronic tube division, Elmira, N.Y. This new tube is three to four times more sensitive to white light than tubes previously used for telescopes. Because it is particularly sensitive to longer wave lengths in the spectrum from yellow to red, the Westinghouse tube can produce daylight pictures of the moon and planets never before possible.

The opto-electronic systems was conceived by Radames K. H. Gebel, a civilian scientist at the Wright Air Development Center's Aeronautical Research Laboratory in Dayton, Ohio. It is now in operation in the Weaver Observatory at Wittenberg College in Springfield.

Gebel and Dr. Lloyd Wylie, professor of astronomy at Wittenberg College, have already used the telescope to produce a composite photograph of the full moon which is made up of more than 200 separate pictures. Forty inches in diameter, the composite picture shows details invisible to ordinary photography methods. For example, the rays of the crater Tycho cannot usually be seen at full moon, but are readily distinguishable with the telescope employing the new Westinghouse tube.

Another advantage in getting a direct view of the full moon, Gebel

Shown 1/18 actual size

How missile designers can use

HACKNEY deep drawing methods

Shown here are a few shapes, shells and missile components produced at production-line speed by *Hackney Deep Drawing Methods.* They were designed to reduce weight without sacrificing strength, save production or assembly time, and lower costs.

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Depths: Up to 110 inches. Two half-shells are easily welded for extra length or symmetrical design. Open ends can be closed by spinning to give an entirely seamless cylinder.

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LITTON INDUSTRIES
Electronic Equipments Division

points out, is the freedom from distortion that goes with photographing at oblique angles. In the past, pictures have had to be taken when the moon's lighting was oblique so that shadows would produce sufficient contrast.

The opto-electronic telescope operates essentially as a closed circuit television system. Images picked up through the telescope are transformed into electrical impulses by the camera tube, and are made visible on a cathode ray tube after passing through a video amplifier. Photographs are then made from the face of the picture tube.

New RCA Unit Formed for Advanced Research Studies

A new high-level scientific and technical organization known as Advanced Military Systems has been established by RCA to create and develop new and advanced weapon system concepts, Arthur L. Malcarney, executive vice-president, RCA Defense Electronic Products, announced recently.

Describing the purpose and function of Advanced Military Systems, Malcarney said:

"The creation of modern weapons in the new age of missiles and space technology, has become more and more a matter of conceiving and developing intricate technical systems. These draw upon our advanced scientific technology and require the highest calibre of engineering skill. In line with this trend, and in view of its current responsibilities as a major contributor to our national security, RCA has formed Advanced Military Systems to 'spearhead' studies leading to the creation of new, complex and ever more effective weapons systems.

"This group is the culmination of many years of evolution in the field of systems engineering at RCA. The philosophy of conceiving and delineating complex military systems has been tested and proven on such programs as Ballistic Missile Early Warning System, airborne fire control, long range communications, and Land Based Talos.

"The objectives of the group will be first to determine the need for specific types of systems to meet specific requirements, and then to originate detailed proposals or 'blueprints' upon which such systems may be based.

"We feel that the organization of Advanced Military Systems, added to the extensive scientific and technical resources already possessed by RCA in its various divisions, will prove to be of major importance to the ad-

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vancement of our technology and the maintenance of national superiority in offensive and defensive weapons systems during the years to come."

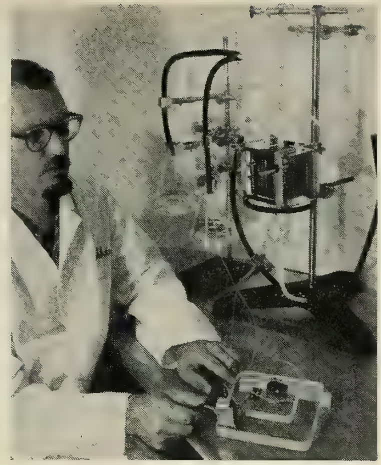
Malcarney pointed out that the new group will function in close cooperation with all segments of RCA engaged in defense work, including the RCA Laboratories.

Lockheed Develops New Energy Conversion Method

SUNNYVALE, CALIF., Nov. 17—A method for converting chemical energy directly into electrical power, which could make quite a change in conventional propulsion systems, is in advanced development at Lockheed Missile Systems division laboratories.

L. Eugene Root, Lockheed vice president and general manager of the missile division, today described a "fuel cell" on which Lockheed scientists are working which has attained high efficiencies in electrochemical conversion.

He said that Dr. Morris Eisenberg, who is directing work on fuel cells, "has repeatedly achieved in laboratory experiments almost 100% of "fuel" utilization and energy conversion efficiencies of 70% or better."



SCIENTIST IN Lockheed Missile Systems division's electrochemical laboratory, demonstrates how a fuel cell converts energy directly into electrical energy to power motor which spins plastic disc.

This compares with a steam engine which has a conversion efficiency of 35 per cent and an internal combustion engine which is even less efficient.

Eisenberg predicted that a fuel cell which would "yield sufficient energy for powering an auto or even a plane could be developed within five years."

Eisenberg said some of the other possible applications, both scientific and commercial, include providing power sources for:

Communications systems and other internal equipment in a spacecraft requiring a long-lasting power supply.

Operation of scanning and recording equipment in such scientific space projects as lunar probes.

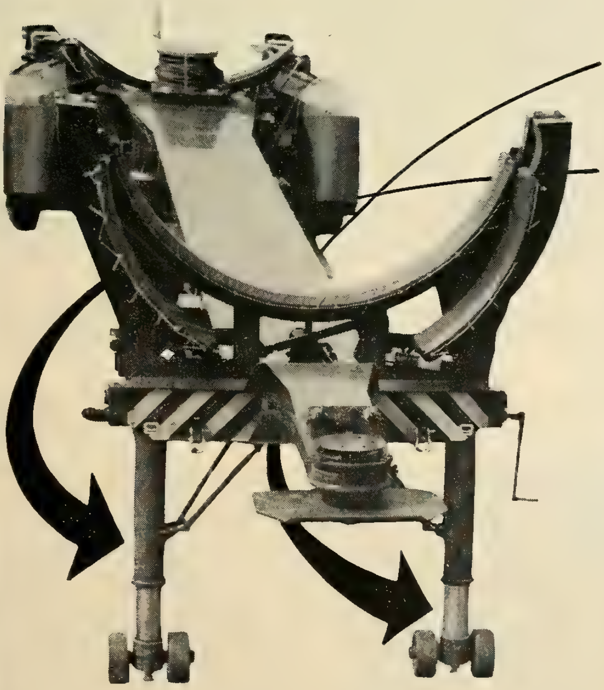
Comparing the fuel cell with the lead acid battery, Eisenberg explained that the basic difference is that in the battery the active materials are inside the case.

"In the fuel cell the electrochemical fuel is stored outside so the components of the cell are not consumed in the electrode reactions," he said.

Energy produced by electrochemical reaction is measured in watt hours per pound of total weight. An automobile battery, for instance, yields between 8 to 10 watt-hours per pound.

By way of contrast, Eisenberg said, a fuel cell presently being developed is designed to produce 100 watt-hours per pound and predicted that one of 300 watt-hours could be developed within five years.

"Even a 150-watt-hour-per-pound cell would produce enough energy to power every type of aircraft or space-



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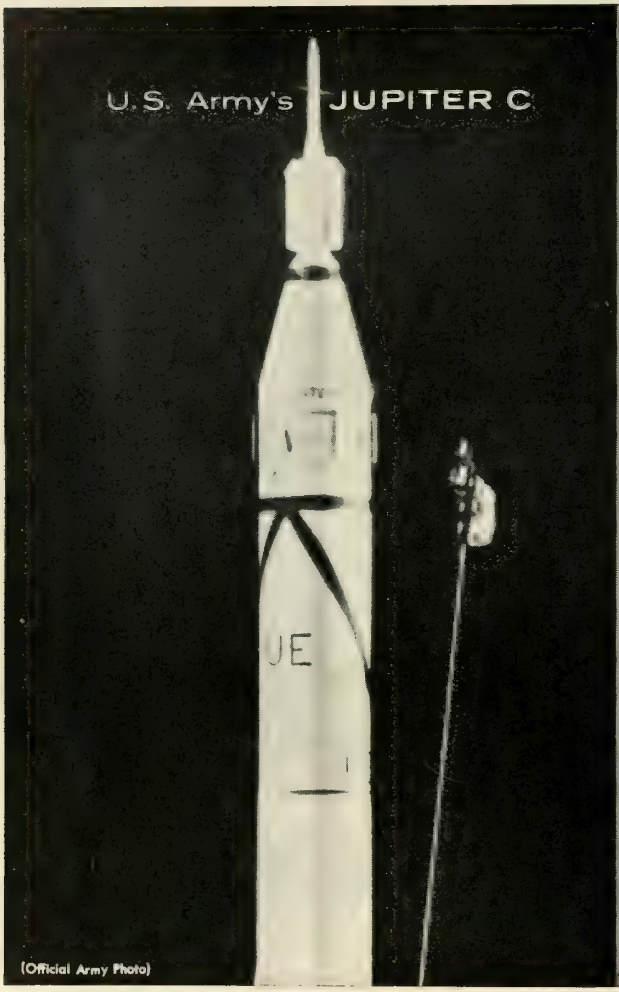

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(Official Navy Photo)

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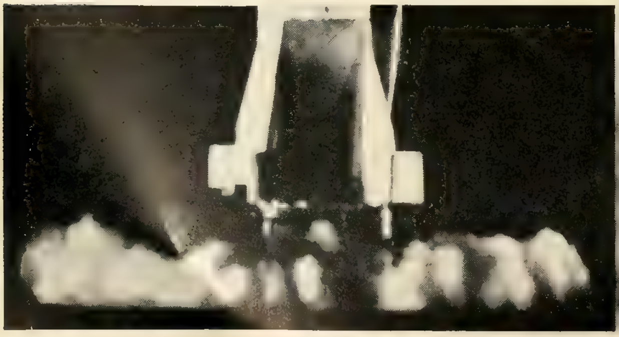
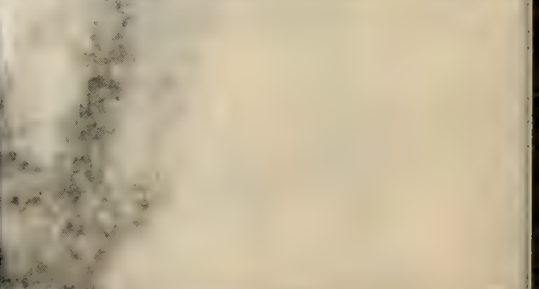
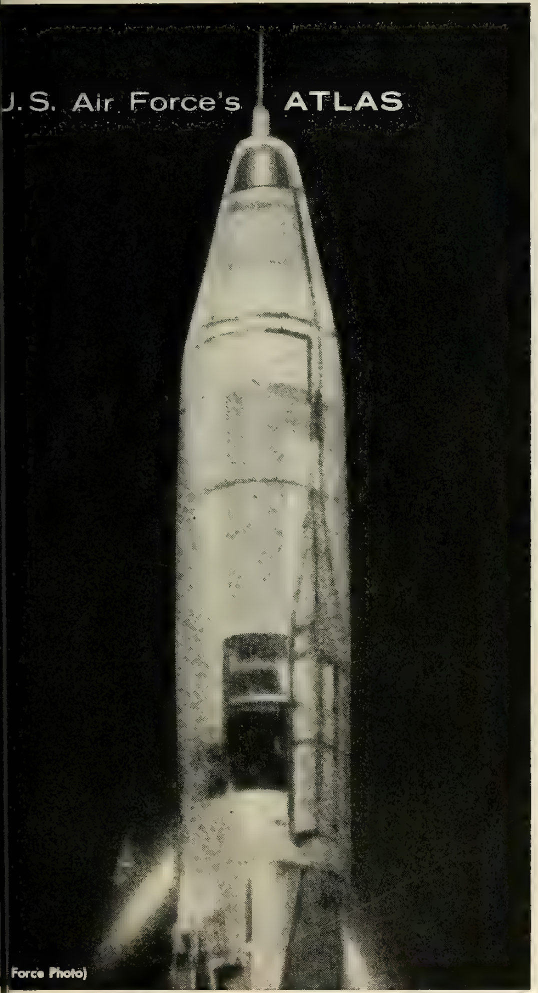




producer of Missile Metals



Force Photo)

for weight reduction
strength

Many types of missile metals are required to meet the severe demands of the space age. Metals to resist heat, to reduce weight, to add strength. Production of these flight weight metals is a Republic specialty.

Stainless steel protects missiles and rockets from the searing heat of air friction. Titanium alloys offer the highest strength-to-weight ratio of any construction metal. Republic produces both of these metals in billets, hot rolled and cold finished bars, plates, sheets, and strips.

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As rapid development in the missile field increases demand for these high-strength, select formula steels, Republic is keeping pace through research and new production facilities.

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craft and to provide power for communication in satellites and space vehicles," he declared.

As to the possibility of the fuel cell replacing the internal combustion engine in automobiles, Eisenberg said it would take only an 80 watt-hour-per-pound cell to excite Detroit's automotive engineers and designers.

Major advantages of the fuel cell, according to Eisenberg, include long operating life, adaptability to both large and small-scale applications, no noise or fumes and ease of maintenance since there are few moving parts.

Miniature Tape Recorder Stores 3 Million 'Bits'

PALO ALTO, CALIF.—A tiny rugged tape recorder capable of storing three million pieces of scientific data as it travels through outer space, has been developed at Lockheed Missile Systems division's research laboratory here.

Small enough to be held in one hand, the unit answers the need for a lightweight versatile communication unit for scientific space missions.

Mark Siera, research scientist in Lockheed's telecommunications department, who developed the AMR-100 (for Airborne Magnetic Recorder) said it is a valuable piece of equipment for lunar probes, manned and unmanned spacecraft, and for interplanetary vehicles.

It can record and store vital data of the universe during long intervals when an interplanetary spacecraft is out of direct radio contact with the earth and then transmit it at an accelerated rate on a command signal when the vehicle returns to within range of the earth's listening posts. It can unload its accumulated information in one-sixth the time it takes to record it.

The recorder has survived simulated rocket launches of 50 times the force of gravity, the Lockheed scientist said.

The compact unit, weighing only eight pounds and measuring nine inches long, five inches high and 4½ inches wide, is one-third smaller than existing recorders with the same capacity. It can function at unlimited altitudes and in any position or axis.

An unusual Lockheed-developed feature, now being patented, is an easily changeable cartridge containing a 600-foot endless loop tape which records two tracks of information simultaneously.

Data is accepted periodically on command and reproduced at six times the recording speed upon another command.

"For instance," Siera said, "48 minutes of continuous recording can be reproduced within eight minutes. The tape can be started or stopped in a fraction of a second, thereby keeping wasted tape footage to a minimum."

The instant after the recorder unloads its data via telemetry to a ground station, it is immediately ready to begin storing new information.

Another feature of the device is the low power input required to operate it. Fully transistorized, only 10 watts is needed for the entire electronics system. In addition, the system is designed so that the power is turned on only when the recorder is in actual operation.

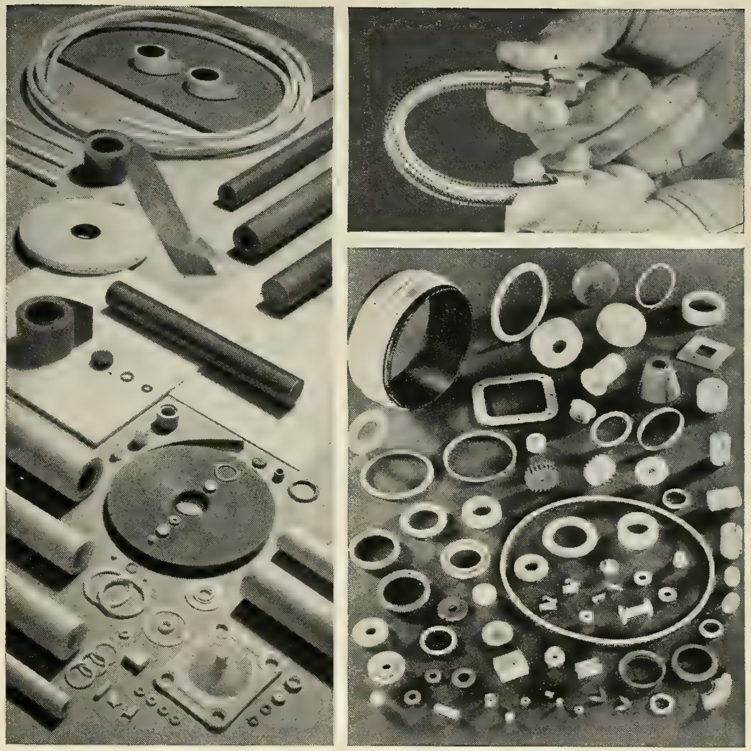
EIA Workshop to Cover Proprietary Information

A one-day workshop on proprietary information will precede the Electronic Industries Associations winter quarterly conference in New York City December 2-4.

Sponsored by the association's Patents and Copyrights Committee, Military Relations Department, the workshop will examine practical approaches for handling proprietary information under government contracts to protect the contractor while meeting the government's needs for second source information, and adequate data for maintenance and repair.

"Proprietary information and its relation to work under government contracts has been a difficult problem," said workshop chairman Elmer J. Gorn of Raytheon. "Few companies appear to have developed a practical set of policies and practices which can serve as a day-to-day guide."

The four-session workshop study



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The Division is systems manager for such major, long-term projects as the Air Force Earth Satellite, Q-5 and X-7; Army Kingfisher; Navy Polaris IRBM and other important research and development programs. It was honored at the first National Missile Industry Conference as "the organization that contributed most in the past year to the development of the art of missiles and astronautics."

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Electronics B.S. in E.E. or equivalent, with experience in one or more of the following: telemetry; instrumentation; radar and communications including radio, radio telephone and high speed teletype; VLR trajectory tracking.

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Flight Test Evaluation Advanced degree required in A.E., M.E., E.E., physics or math with minimum 5 years' experience in one or more of the following: technical control of missile systems tests; analysis and evaluation of missile systems performance; preparation of systems reports; missile flight test activities in blockhouse, countdown and launching operational performance evaluation. Liaison with the military is an important part of these assignments.

Flight Test Operations B.S. in A.E., M.E. or E.E. with 5 years' experience in missile flight test operations for blockhouse, countdown and launching activities. Liaison with the military is an important part of the assignment.

Theoretical Physics M.S. in physics required, Ph.D. preferred, with experience in space physics, or nuclear physics applications; infrared and other detection methods, with ability to evaluate flight test program effectiveness.

■ **For Information** regarding these and other related positions, please write: Research and Development Staff, Dept. 2211, 962 W. El Camino Real, Sunnyvale, California.

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will deal with these aspects of the problem: a definition of proprietary information, headed by Robert V. Faragher of RCA; an interpretation in practical terms of the recently issued Part 2 of ASPR IX (Technical data), under Ben Edelman of Westinghouse; preparation for contract negotiations involving PI, headed by Roe McBurnett of General Electric, and techniques for monitoring the handling of proprietary information within the contractor's organization, headed by committee chairman Gorn.

What the new Defense Education Act will mean to the electronics industry will be detailed at a luncheon December 3 by U.S. Assistant Commissioner of Education for Research, Dr. Roy Hall.

The following legislation, due to come before the new Congress which convenes in January, will be taken up by committees at the conference:

—The Saltonstall bill which would extend the weapon system concept to all large military systems and exempt incentive fixed-price contracts from renegotiation. Questionnaires have gone out to the members of the Systems Management Committee to assess the effect of the weapon system concept on small business and its effect on management efficiency.

—Indemnification legislation which would permit the Defense Department to insure its contractors against unusually hazardous risks. Although similar legislation was introduced in the last session of Congress, it was not reported out of committee in time for action before adjournment.

—Renewal of the Renegotiation Act.

Talos Shown in New York at Electronics Exhibit

The supersonic, surface-to-air *Talos* missile is the top attraction at a new display of electronics developments recently unveiled at RCA Exhibition Hall in New York City.

The exhibit features both new major defense and consumer electronic products. It includes a basic-relief map of the 5,000-mile Atlantic Missile Range—from Cape Canaveral to Ascension Island in the South Atlantic, and a miniature model of the FPS-16 missile-tracking radar system.

Talos, built by Bendix Aviation Co. is used on Navy warships.

The missile was hoisted by derrick through an exhibition hall window, in two sections: The booster, 10 feet long and 30 inches in diameter, weighing 1,000 pounds is a solid fuel rocket

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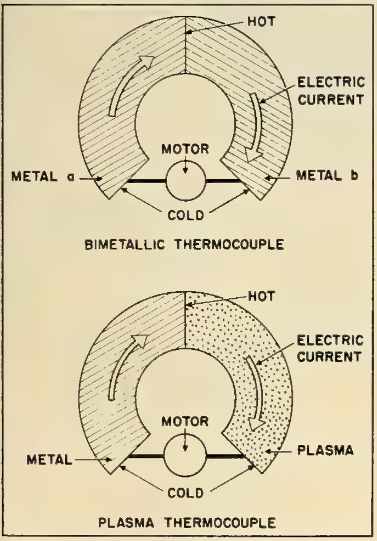
which is jettisoned after propelling the warhead section faster than a bullet. The warhead section—is 20 feet long, weighs 2,000 pounds, and when in use, contains a 40,000-horsepower ramjet engine.

Plasma Thermocouple Developed at Los Alamos

A plasma thermocouple, which can convert nuclear reactor heat directly into electricity to power instruments in artificial satellites has been developed by the Los Alamos Scientific Laboratory. The new generator which has no moving parts, is expected to be the forerunner of a nuclear reactor-plasma thermopile which would produce electricity through atomic fission.

Developers of the new generator, who are currently working on tests for the thermopile, are G. M. Grover, William Ranken, D. J. Roehling, E. W. Salmi and R. W. Pidd, consultants to the laboratory from the University of Michigan. Theoretical analysis of the plasma thermocouple was developed by laboratory consultants, J. R. Reitz of Case Institute and H. W. Lewis of the University of Wisconsin.



SKETCHES SHOW the essential differences between two kinds of thermocouples.

The new thermocouple uses an electric plasma—a "fourth state of matter." While thermocouples usually use two kinds of metal fused together, this one uses only one. The other is replaced by the plasma, an ionized gas.

In addition to its use in satellites, other applications include interplanetary propulsion and current for consumer use.

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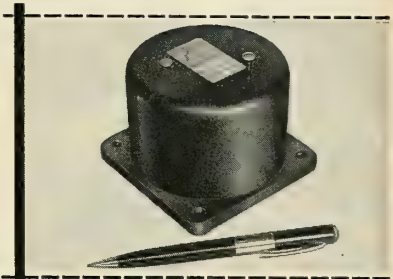

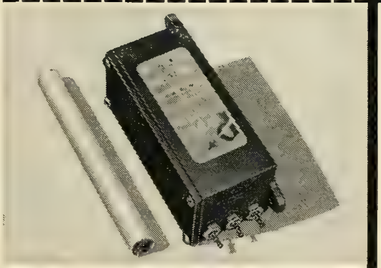

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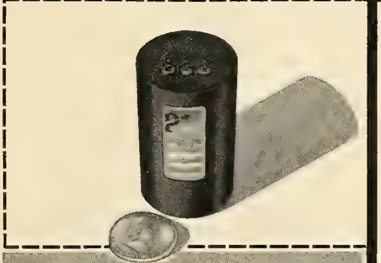

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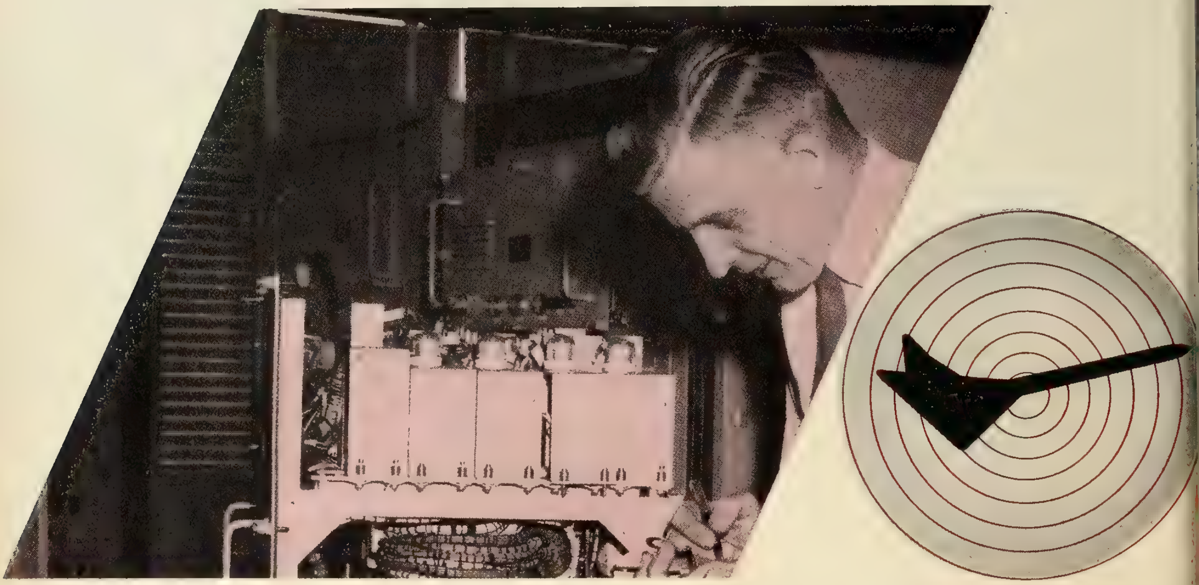
TEST EQUIPMENT ENGINEER John W. Lloy tells why his work in the B-70 weapo system at IBM Owego affords him the c ative engineering career he always wante

what's it like to be a creative engineer at IBM?



Assignments now open include . . .

MAGNETICS ENGINEER to design and analyze magnetic core circuitry for use in advanced digital computers. Assignment entails application of these circuits to logical connectives and systems. **Qualifications:** B.S. or Advanced Degree in E.E. or Engineering Physics and 2 to 5 years' experience with magnetic circuitry. Must be familiar with fundamentals of non-linear magnetics and have strong interest in logical circuit application of magnetics.

PACKAGING ENGINEER to undertake development and design of packaging techniques and mechanical design of electronic equipment; to investigate temperature effects on packaging; to offer design support to computer, radar, and inertial development groups; to analyze present and proposed packaging design and recommend improvements.
Qualifications: B.S. in E.E. or M.E. and experience or advanced knowledge in latest electronic packaging techniques.

RADAR ENGINEER to analyze ultimate limits of present techniques and develop new concepts of providing topographical sensors for advanced airborne and space systems; to design airborne radar pulse, microwave and deflection circuitry; to analyze doppler radar systems in order to determine theoretical accuracy and performance limitations.
Qualifications: B.S. or Advanced Degree in E.E. and 3 to 5 years' experience in radar systems development, including display equipment and circuits, control consoles, and doppler or search radar design.

CIRCUIT ENGINEER to undertake advanced circuit design based on transistor-diode logic for digital systems; to review new circuits for application in digital control systems; to define bas techniques for improving performance characte istics; to participate in advanced analytical stu ies associated with application of transist circuitry to pulse and digital systems.
Qualifications: B.S. or Advanced Degree in E. and 2 years' experience with pulse circuitr transistor circuit design or digital techniques.

GROUND SUPPORT EQUIPMENT ENGINEER assist in planning complete ground suppo equipment, including flight line, shop and dep equipment, for an advanced airborne weapon system. Must be experienced in development test equipment for automatic checkout of com plex weapons systems, including computers radar, and inertial equipment.
Qualifications: B.S. or Advanced Degree in E. or related fields and 3 years' experience in deve oping ground support equipment.

A wide variety of exciting career opportunities awaits creative engineers and scientists at IBM Owego in applying IBM's computer technology to integrated B-70 bombing-navigation systems. Test Equipment Engineer John W. Lloyd, describing his assignments at IBM Owego, says: "Test equipment engineering is particularly stimulating when it's part of a project as new and important as the B-70, sometimes described as a 'huge flying computer.' Right now I'm coordinating the design of engineering support equipment for an advanced digital airborne computer, part of the B-70's bombing-navigation and missile guidance system. There's a minimum of routine. In order to design test equipment you must know—or learn—about the equipment to be tested; among these are radar, servo systems, digital and analog computers, and inertial guidance. I see my professional growth assured as IBM continues to develop computers for airborne applications."

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Science Information Meeting Explores Automation

WASHINGTON, D.C.—The problem of the storage and retrieval of scientific information was explored by specialists from more than a dozen countries at an International Conference on Scientific Information, held in Washington, D.C., November 16-31, under the sponsorship of the National Academy of Sciences—National Research Council, National Science Foundation, and American Documentation Institute.

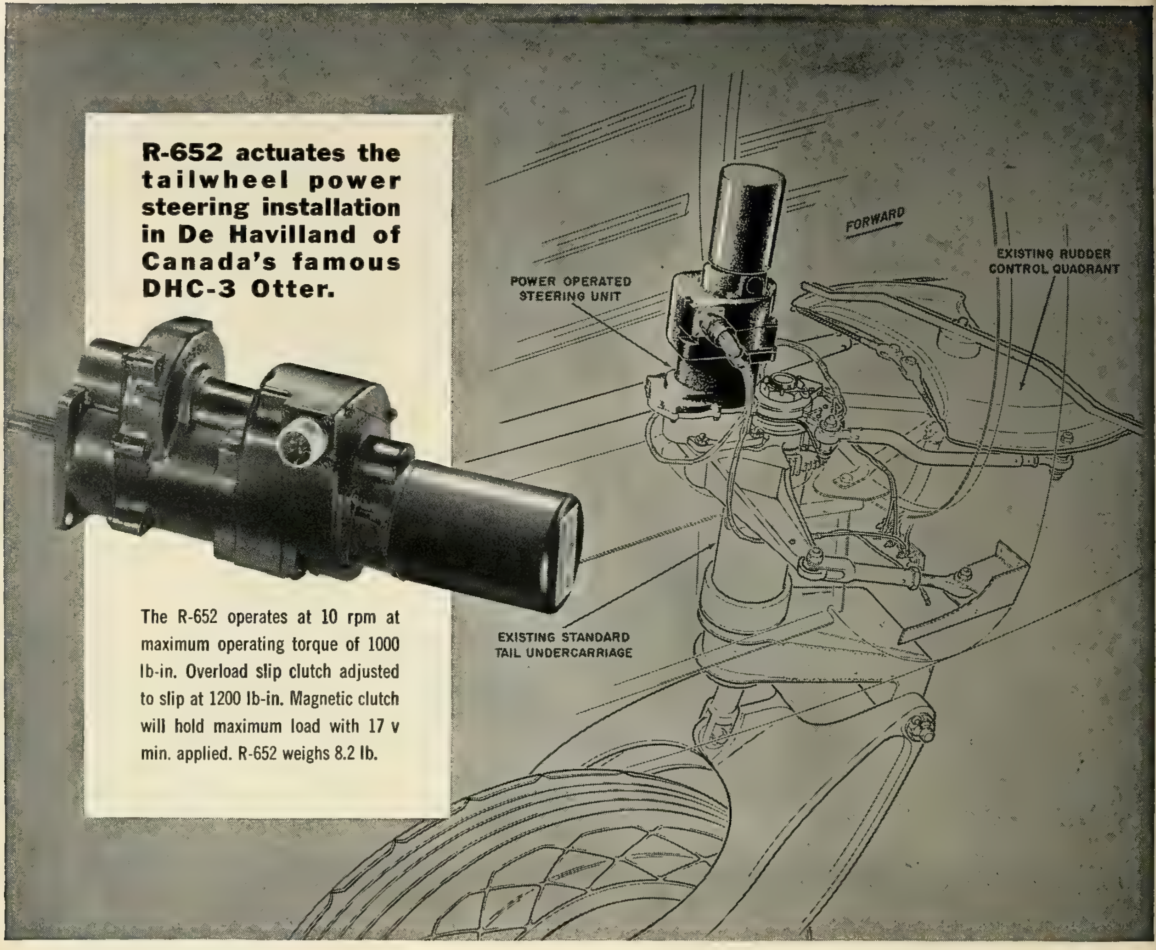
Without convenient and rapid access to data from previous research, scientific progress is impeded. Under ideal circumstances, all such data is first published in full for workers in the immediate field; then abstracted for dissemination; indexed, codified, microfilmed or otherwise processed for storage; and, finally, retrieved in library search.

During recent years, however, the outpouring of data has all but overwhelmed the thin brigade of abstracters, indexers and other information specialists trained for the task. Quite simply, more scientific information is being produced that can effectively be stored and retrieved, and that body of information is said to be doubling every ten years.

Since the nature and scope of the problem was first examined formally by the Royal Society of London in 1948 and Unesco in 1949, various solutions have been offered—including many ingenious proposals for the use of mechanical and electronic aids in the preparation of material for storage and retrieval. Some of these methods have already been put to use and were described at the conference; others, such as mechanical devices for translating and abstracting, are still in the design or conjectural stages.

Although there is some controversy over the most promising solutions to the problem of storage and retrieval, there is little disagreement about its magnitude. At the present time, many investigators find it less expensive to conduct laboratory experiments anew than to search for previously reported data.

The conference program—which had been three years in preparation—included discussions of the kind of information scientists need, the effectiveness of present-day systems for organizing information, intellectual and mechanical problems encountered in the development of new systems, the search for a general theory, and finally a consideration of the responsibilities of government, professional societies, universities and industry.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Drawing courtesy De Havilland Aircraft of Canada, Ltd.

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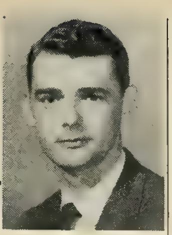

by Raymond M. Nolan

Competition is getting hotter in the *Dart* replacement battle. Latest word is that Vickers is flying 25 of their *891* missiles and several technicians over so that evaluation can start. If the *891* is chosen, the only change from the present bird will be in electronics. Circuitry will be redesigned to use American transistors to ease maintenance problems.

Army Ordnance still says that the *SS10* or *SS11* will be the replacement, but people close to the situation claim that these missiles would wind up the same way as the *Dart* because "the *Dart* specification is impossible to meet." Vickers does not claim that the *891* can fill the spec—but it will do the job wanted—a lightweight hand-carried anti-tank missile, easy to set up and simple to operate for its one-man infantry crew.

There is still another contender though—the German-developed *Kobra.* Even though Pentagon officials say that the *Kobra* is "a dead item," don't discount this entry. The control system which reportedly made the U.S. shy away may be due for a change. Reports are that the Germans are now dickering with Vickers for the rights to the *891* control system for installation on the *Kobra.*

At any rate, it should be an interesting battle. But while it rages on, no development work or planning for this important weapon is in progress. It seems as though an early decision should be made if the new battle mobility concept of the Army is to proceed along planned lines.

Dr. Nicolaas Bioembergen, professor of physics at Harvard's Cruft Lab brought down the house at the recent NSIA ARDC-sponsored Molecular Electronics Symposium when he showed a slide of the radio telescope at the Naval Research Laboratory and said, "anyone who can afford a dish like this, can't afford not to use a MASER with it."

Dr. Bloembergen also described a new traveling wave MASER developed by Bell Labs. Performance is: forward gain, 23 db; backward attenuation, 29 db; tunable range, 5.8 to 6.1 kmc; bandwidth, 23 mc; and a noise temperature of 8 degrees K. The MASER uses a low-chrome pink ruby forward and a high-chrome red ruby backward with garnet slated to replace the red ruby. Pumping is 100 mw at K-band with 0.1 mw into the paramagnetic materials.

Another development reported was a ruby MASER working at 77 degrees K at the Royal Radar Station in Great Malvern, England. The noise isn't too good, but is an improvement over existing systems.

However, Dean Harvey Brooks of Harvard's School of Engineering stated in a talk on the same program that he did not see much possibility in solid state MASERs at room temperature.

At any rate, you can expect to see more and more interest in molecular electronics as various NASA and DOD space programs shape up. It is generally conceded that it is far easier to use MASER's in the receiving apparatus than to attempt building transmitters into the space craft large enough to overcome galactic noise. Size and operating temperatures are a problem but can be overcome fairly easily in ground installations.

And another remark made at the recent Electron Devices Meeting in Washington stands out, "We must examine all ideas very carefully, for the idea which seems worthless today may be of absolutely no value a month from now."

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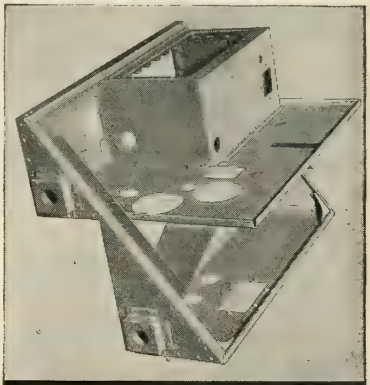
TITANIUM?
STAINLESS?
ALUMINUM?



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space age

by Norman L. Baker

Decontamination for public pacification—Leading space medicine scientists believe sterilization of lunar payloads is a waste of time and current probes are only being made germ-free to "satisfy the public." Dr. Hubertus Strughold, Research Advisor for the AF School of Aviation Medicine, says there is only the smallest chance that earth microbes could survive on the moon even in the slight traces of atmosphere that might be trapped in the lunar craters. An ABMA scientist, agreeing with Dr. Strughold, says that the rocket's skin would be completely sterilized by the ultraviolet rays from the sun en route.

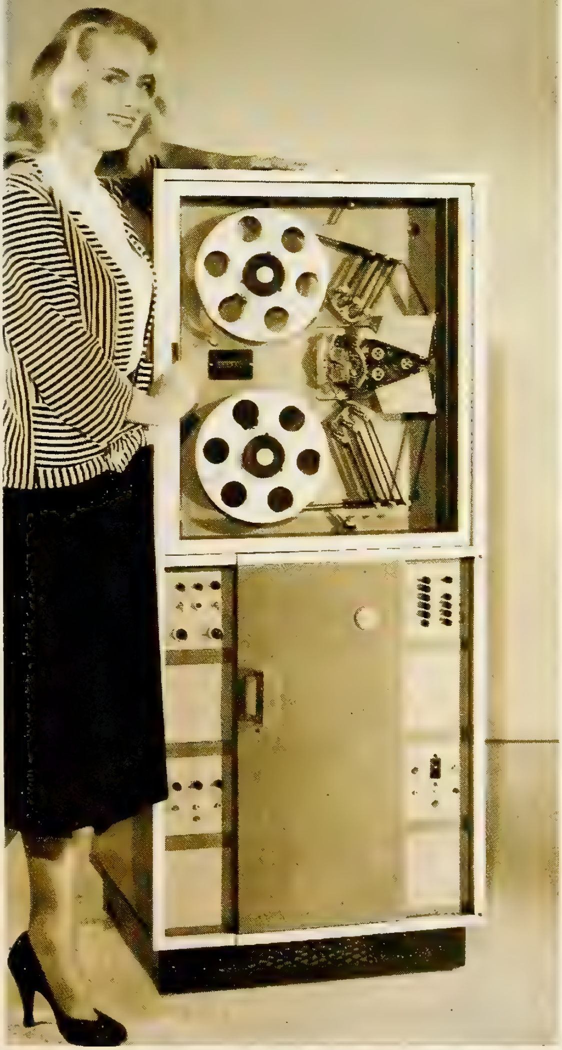
Venus or Mars will provide germ breeding ground—On the other hand, payloads sent to the atmosphere-enveloped planets of Venus and Mars will require maximum sterilization if we wish to protect any living organism that may exist there. For instance, pneumonia and tuberculosis germs, micro-organisms that subsist on carbon dioxide, would multiply at a tremendous rate on Venus with its heavily loaded CO_2 atmosphere. The entire organism population of the planet could be wiped out in a short time if the organisms failed to produce antibodies fast enough or strong enough to counteract the transplanted earth germs.

Moon a dead planetary body?—The recent report that a volcanic eruption had occurred on the moon, by "highly able and professional" Russian scientists, has brought conflicting reactions from leading astronomers. British astronomers branded the report "nonsense" and are viewing it with skepticism until two or more similar reports are made by astronomers of other nations.

Russian discovery collaborated—Dr. Dinsmore Alter, former director of Griffith Observatory, has collaborated the Russian discovery by reporting the presence of what he termed seeping gases on the floor of Alphonsus crater, the one in which the volcanic eruptions was reportedly photographed by the Russians. Alter added that an extensive series of photographs he had taken revealed an obscuration on the western side of the crater's 70-mile wide floor. Previously, most scientists have believed that all moon craters were formed by meteorite impacts.

Project Rotor—*Sputnik* III and its last stage launching rocket, regarded as the most valuable and spectacular satellites put into orbit, are destined to yield more invaluable data before their demise. The final stage rocket, calculated to end its orbiting life about December 4, is the object of a new study by the Research Station for Satellite Observation at the Harvard College Observatory. The study will calculate motions of the satellite about its own center of gravity. Now tumbling about its CG every 18.5 seconds, it causes two reflections of light, each about nine seconds long. By measuring the increase in the time interval between the light flashes as the satellite drops nearer the earth, precise measurements of the atmosphere's density can be made. Project Rotor is investigating the angle between the orbit at a particular moment, plus the tumble axis and the angle through which the tumble axis precesses.

new speed in digital data processing



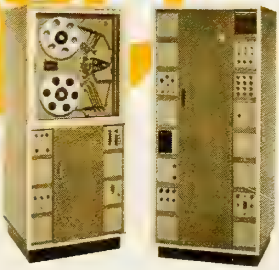
Encompassing the latest in packaging and reliability, Consolidated's new MicroSADIC commutates and converts up to 10,000 analog inputs per second. Outputs are recorded on digital magnetic tape in pre-selected formats compatible with most computers and peripheral equipment. Digitizing may be in either bipolar binary, bipolar binary-coded decimal, or unipolar binary-coded decimal form. Completely transistorized, the system is packaged in modular "slices" for unusual flexibility. Write for complete story in Bulletin CEC 3004-X6.

systems division **Consolidated Electrodynamics**

300 N. Sierra Madre Villa, Pasadena, California

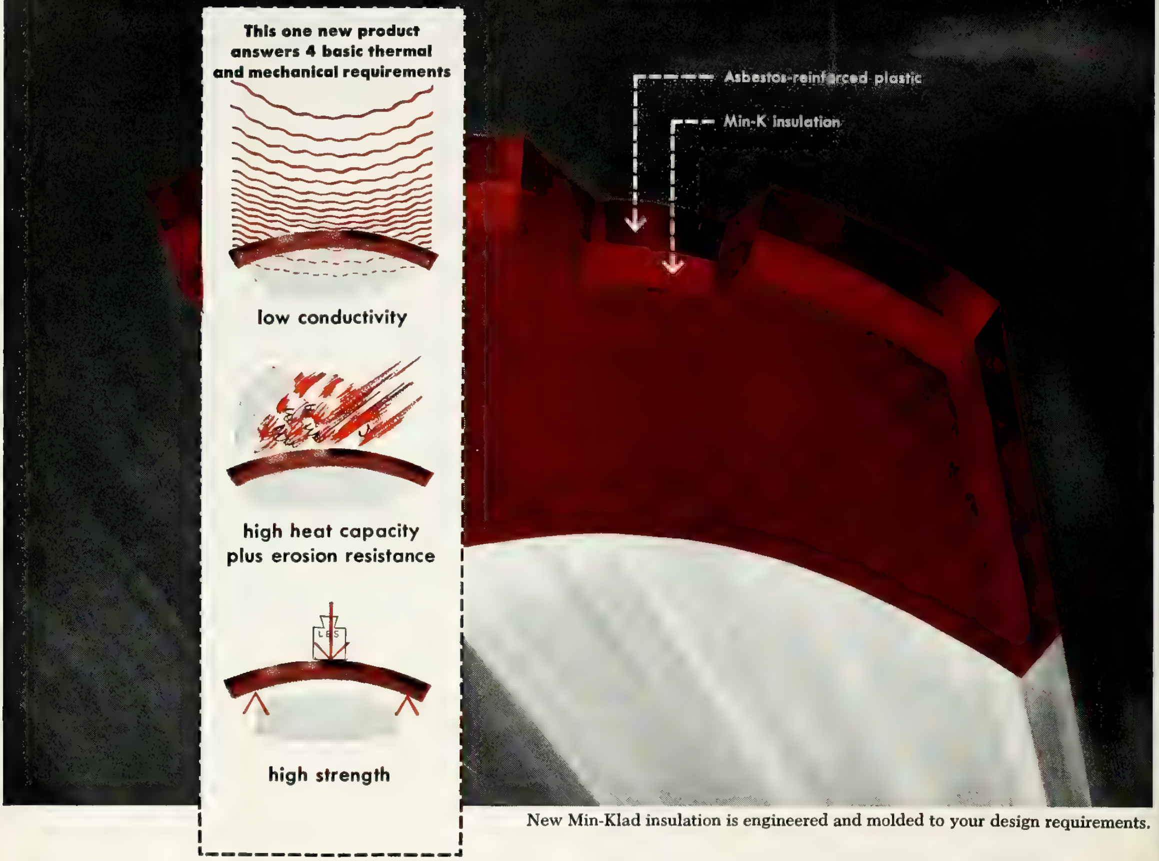
Offices in Principal Cities Throughout the World **CEC**

FOR EMPLOYMENT OPPORTUNITIES
with this progressive company, write
Director of Personnel.



The basic MicroSADIC consists of a commutator, digitizer, system programmer, time programmer, and digital tape unit. All-transistor circuitry on printed boards results in low power consumption and trouble-free operation.

Johns-Manville announces new MIN-KLAD Insulation!


This one new product answers 4 basic thermal and mechanical requirements
low conductivity
high heat capacity plus erosion resistance
LBS
high strength
Asbestos-reinforced plastic
Min-K insulation

New Min-Klad insulation is engineered and molded to your design requirements.

Combines the capabilities of asbestos-reinforced plastic with the dramatically low conductivity of MIN-K insulation!

New Min-Klad insulation may well be the most significant advance ever made in missile and rocket insulation.

Developed by Johns-Manville research scientists, Min-Klad is the only product of its kind, a permanent lamination of the missile industry's two most effective high-temperature materials: 1) reinforced plastic and 2) J-M's recently developed Min-K insulation.

Does more than plastic alone

Min-Klad gives the missile designer all the advantages of high-temperature plastic: Strength, toughness, rigidity! Erosion resistance! High heat capacity! Yet Min-Klad does more.

It also insulates . . . and with dramatic effectiveness! Its insulating element is J-M's Min-K, an insulation with thermal conductivity that is lower than any other known insulation. Actually lower than the molecular conductivity of still air. And this conductivity (already less than half that of the best fibrous insulations) drops still further with altitude. At 10 miles, for example, it is decreased by as much as 40%, with further decreases at greater altitudes.

Wide range of applications

Min-Klad offers the missile and rocket designer a rich choice of heat-control possibilities. It may be used for a part that must insulate, yet have the structural advantages of plastic. Where requirements call for a scuff- and erosion-resistant insulating surface...or for a good adhesive bond between Min-K insulation and other surfaces. Or, it may be used to control high transient temperatures! For high heat capacity of asbestos-reinforced plastic combined with the low conductivity and heat capacity of Min-K result in a product that provides minimum heat transfer under transient conditions.

Min-Klad is now being tested for approximately two dozen missile and rocket designs. Why not investigate this new material for your present thermal requirements? Upon request, we'll be pleased to send you a sample of the material along with detailed technical information. Write Johns-Manville, Box 14, New York 16, New York. (Ask, too, for information on Min-K insulation and the new aviation insulation brochure IN-185A.) In Canada: Port Credit, Ontario.

JOHNS-MANVILLE JOHNS-MANVILLE JM PRODUCTS

Vandenberg Readies for First Missile Firings

by Robert Mount
Special m/r correspondent

VANDENBERG AFB, CALIF.—The Air Force is virtually ready to begin its countdown for the first ballistic missile launching from the West Coast.

Eight launching stations in the *Thor* IRBM complex at isolated Vandenberg AFB in North Santa Barbara County are more than 99% complete.

Ballistic Missile Division and Douglas Aircraft Co. are reportedly moving quickly in preparation for the first four launchings from the Strategic Air Command's first operational ballistic missile site.

The first launch is expected in a matter of days and the first West Coast satellite launching, utilizing a *Thor* vehicle is anticipated on November 30 or December 1. This may be a test version of WS-117L, although a December 19 date is rumored.

In addition, the three pads in the initial *Atlas* complex are 94% complete, indicating an operational capability will be achieved for ICBM launchings in the very near future.

• **Titan pad progressing**—Completion of a second *Atlas* complex is expected by mid-spring. The *Atlas* and *Thor* complexes represent initial contracts of over $18.5-million. Completion date of the first *Titan* pad, now well along in construction, is indefinite.

Before January the Air Force expects to have let $62-million of the estimated $100-million cost of initial construction.

The *Thor* guidance facilities have already been completed and the $1.6-million oxygen plant is 97% complete.

Underground communications facilities for the *Atlas-Thor* complexes are 96% complete. The guided missile maintenance and assembly facilities costing $1.7-million are 99% complete, along with roads to the *Thor* complex. The *Thor* pads can be considered ready to do business.

Basic construction was completed by the U.S. Corps of Engineers last month when their facilities were turned over to the Air Force for technical completion and final check out.

As soon as the first *Thor* launching is complete the Air Force can look forward to the beginning of intensified training of missile men by the First Missile Division at Vandenberg.

• **RAF in training**—Some 160 Royal Air Force personnel and about 50 USAF missile men are already in training, although their work is presently heavily weighted with blackboard rather than practical field instructions.

Small parts requiring very close tolerances and numerous machine operations have been our specialty during the past half-century! We invite your quotation requests and suggest that you write for our illustrated brochure to see how our facilities can be put to work for you!

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4635 WEST LAKE ST., CHICAGO, ILLINOIS
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PHOTOCON ELECTRO-MAGNETIC COUNTERS

—compact, reliable units for telemetering readout and control

These Photocon counters add and/or subtract electrical pulses at speeds up to 20 counts per second. Each digit on each wheel has a contact, for remote indication or control. Counters available with precision resistors mounted between contacts. Counter provides an analog or digital output.

High accuracy—there is no gain or loss of counts over a life of 10,000,000 counts. A balanced armature insures accurate counting during severe vibration.

High reliability—contacts are made from precious metals to eliminate contact noise. Wearing parts are built of Nylon for long life.

Small size—only $1\frac{13}{16}$" high x $3\frac{1}{2}$" wide x $3\frac{1}{4}$" deep. Weight is only 22 ounces. Available in 3-, 4-, and 5-digit counters...also in shaft-driven models. Units can be preset, and hand reset. Write for literature on Photocon Model MCP-1005.

PRP / PHOTOCON RESEARCH PRODUCTS
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A Complete Line of Electro-Mechanical Counters and Digital Clocks

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OF TELECOMPUTING CORPORATION

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Leaders in electrically driven and spring-wound free gyros, rate and floated rate gyros for missile systems—rate of roll, pitch, and yaw indicators for manned aircraft—bank and turn indicators.

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Pioneers in equipments for fast and accurate analysis of test data, with automatic recording on punched cards, tapes, or printed lists—for aircraft, missile, industrial and scientific uses.

ENGINEERING SERVICES
Currently engaged in reduction and analysis of flight test data generated by daily missile firings at Hollman Air Force Base, White Sands Proving Grounds Integrated Range.

WHITTAKER CONTROLS
The largest developer and builder of custom-built high-performance hydraulic, pneumatic, and fuel valves, controls, and regulators for advanced missile, aircraft, and industrial applications.

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Designers and builders of high quality, reliable equipments for prelaunch checkout and testing of nuclear special weapons.

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RFORMANCE REQUIREMENTS

a pressure actuated valve,
trolling flow of helium for
(tank pressure regulation:

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5°F to +120°F

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50°F for 5 seconds, then to
00°F in 25 seconds

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3000 psi in ½ second

trol Tolerance
psig. +zero, −1.3 psi,
mall ullage

ponse Time
o to rated flow in ½ second.

ign considerations:
e of flow of helium
xed by rate of evacuation
OX tank;
tion in all metering elements
st be minimal
ll temperatures;
tter must be prevented
pite pressure shock;
oonse must be rapid
pite long signal
sing lines.

ults: A valve
N 121485)
eting all of these requirements
ow operational —
ther Whittaker
tribution to
erica's missile program.

WHITTAKER CONTROLS OFFERS THE INDUSTRY'S TOP FACILITIES FOR:

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These facilities,
together with the
industry's
most resourceful and
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and technical personnel,
are at your disposal,
to solve your
most exacting hydraulic,
pneumatic, and fuel valve
and control problems.

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915 North Citrus,
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Hempstead (Long Island), N.Y.

move it in . . . couple it . . . turn it on . . .

with a VICKERS® "packaged" unit power is instantly available to operate your missile-support system

Fast and easy installation is an important advantage of these "packaged" hydraulic power and control systems by Vickers. It saves time at the missile site — keeps "on-the-spot" labor charges low. That's important! Yet this fast installation is only one of the benefits you get with these factory-built power packages.

Save Design Time — Since 1932 Vickers has custom designed hydraulic power packages. Thus, we know how to avoid "false starts" and can develop highly efficient units *in a hurry.*

Eliminate Mismatching — Each power package contains compatible, balanced components all produced by Vickers. There are no hybrids — there is no need for "force fits".

Save Space — Units are surprisingly compact, yet all components are easily accessible. Solid steel drilled manifolds reduce piping and space. Components, lines and connections are kept to an absolute minimum.

Simple Field Adjustment — The building-block concept is followed to give component interchangeability, servicing ease and quick location of any malfunction. All components are individually tested; complete power units are pretested before shipment.

Insure Predictability — Vickers designs and builds systems which meet the most rigid performance specifications including predicted ambient temperature, weather and other conditions.

Reduce Field Inventory — As far as possible, units are designed with components that are commercial "shelf" items. Inventories of warehouse stocks can be kept low because of component and part interchangeability.

How far advanced is your project? If it is in the design and development stage, we can *immediately* place a team of hydraulic specialists in your plant to work with your engineers. If it is in the "breadboard" stage, let us give you an alternate proposal. On many applications we have suggested much improved power units at attractive production-line prices.

Write for Bulletin 5303
"Vickers Oil Hydraulics for Missile Systems"

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Hydraulic Products for Marine and Ground Defense Applications

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Circle No. 48 on Subscriber Service Card.

Decision Expected Soon on U.K. Space Program

LONDON—A committee of the Royal Society, equivalent to the U.S. National Academy of Sciences, is advising the U.K. government on the feasibility of establishing a British spaceflight program, and to investigate projects which might be undertaken with satellites and probe rockets.

Speculation that an announcement was imminent concerning the government's decision on such a program was denied at the opening of a discussion meeting on space research held here, and indications were that a firm decision has not yet been made.

Immediately following the meeting, a charter, rules of procedure and plan of organization were drawn up for the International Committee on Space Research, subject to approval by the International Council of Scientific Unions. It was reported that the International Committee, at its first meeting, had reached agreement that any country would be allowed to carry out space experiments using American or Soviet satellites (m/r, Aug. 18, p. 33).

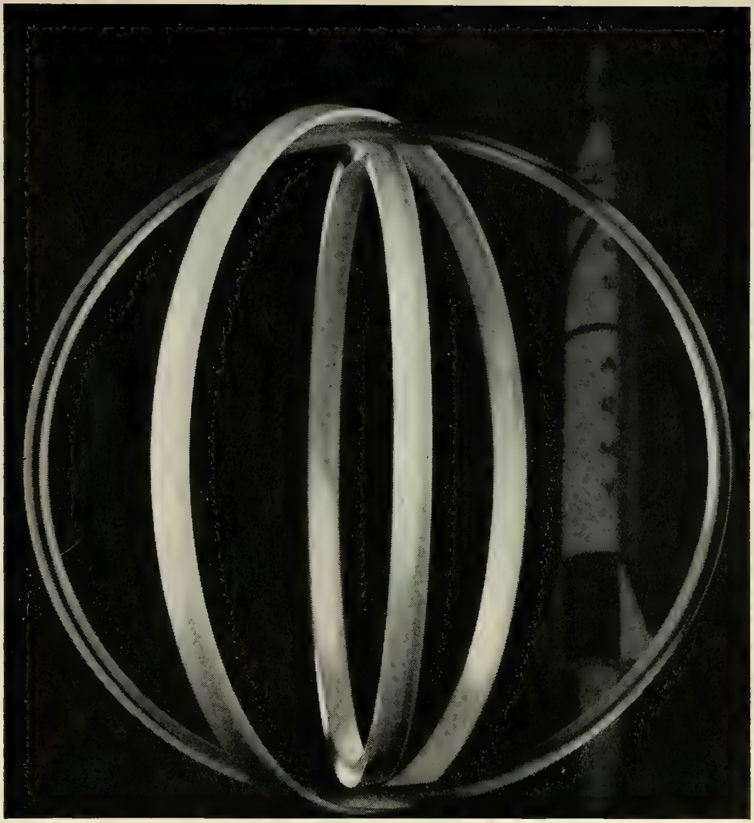
Applications by foreign scientists to put their equipment aboard satellites would be decided on merit by the committee, and the equipment placed aboard the particular satellite considered most suitable. The Soviet scientist reportedly insisted that details of their rockets and methods of launching remain secret.

During the meeting itself, Prof. S. Chapman, formerly of Oxford University, advanced the theory that the sun's corona extends beyond the earth and that its temperature in the region of the earth's orbit was around 220,000°C. This, according to Prof. Chapman, was the source of heat flowing downward into the upper atmosphere, and the earth was in effect a cold spot in a hot gas. The theory was supported by recent findings that temperature gradients in the upper atmosphere are several times steeper than believed.

New Missile Ship Ready on West Coast

PORT HUENEME, CALIF.—The multi-million dollar experimental and training missile ship King County has joined the growing fleet of special Navy vessels assigned to the Pacific missile range.

The King County is in Port Hueneme Harbor near Point Mugu. She is a converted LST carrying a mockup of the *Regulus II* and the conning tower, launcher, television cameras and a hangar for the Halibut and her sister submarine, Grayback.



new techniques match TEFLON to missile needs

Don't underestimate the possibilities of du Pont TEFLON as fabricated, today, by United States Gasket Company. Perennial pioneers and leaders in advanced techniques of manufacture and application of TEFLON T.F.E. fluorocarbon plastics—recent U.S.G. developments bring an entirely new conception of the scope of usefulness of this remarkable material in the missile field. One example—"Fusion welding" of TEFLON T.F.E. has broken through the limiting size barrier of fluorocarbon plastic structures. Another example—"filled" TEFLON is providing materials with particularly desired characteristics not possessed by the virgin material—new qualities "custom-tailored" to specific use requirements.

United States Gasket Company engineers invite the opportunity of applying the latest TEFLON techniques for the solution of your design problems.

For prompt service, contact one of The Garlock Packing Company's 30 sales offices and warehouses throughout the U.S. and Canada, or write

United States Gasket Company
Camden 1, New Jersey

United
States
Gasket

Plastics Division of
GARLOCK

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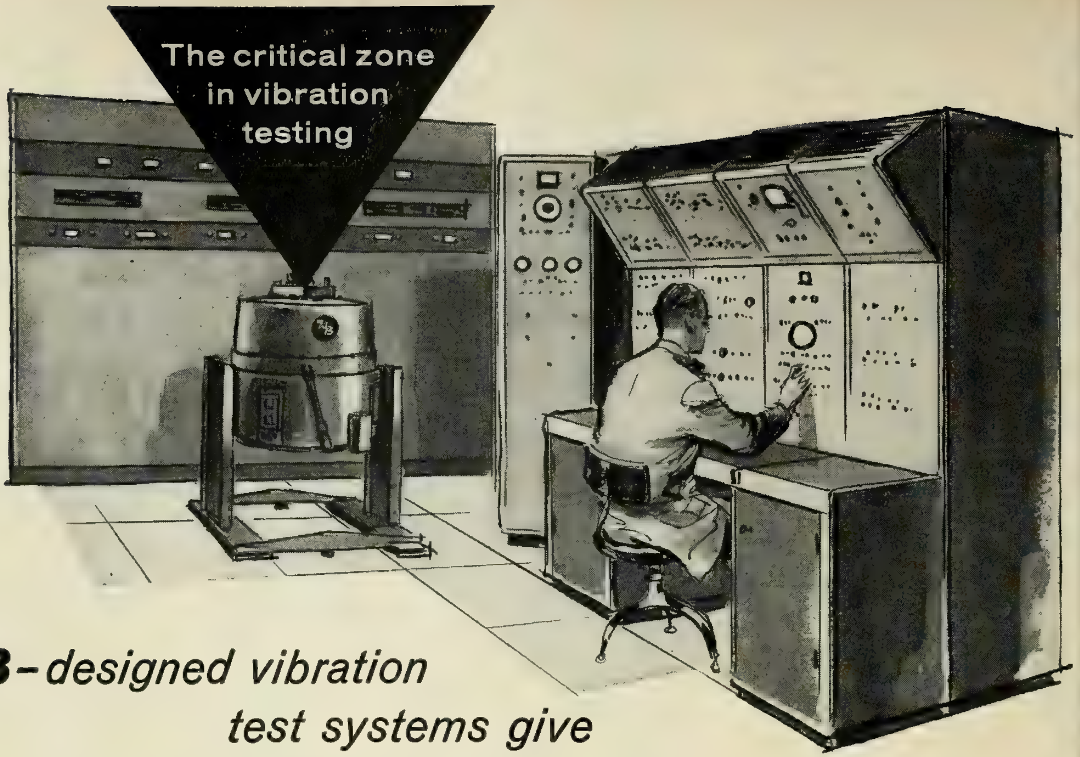
The critical zone in vibration testing

***MB**-designed vibration test systems give*

high performance table motion

It's *System Performance* that counts most in vibration testing.

Whole purpose of a vibration test system, large or little, is to subject specimens to *motions* that simulate service conditions as closely as possible. Such motion gives you *reliable* information on vibratory response and performance of structures, products, components. It helps reduce risk of malfunction or failures in the field.

But many factors contribute to this motion. Among them: force output and characteristics of the exciter; ample and undistorted power supply to meet all shaker-plus-specimen load relationships; meticulous matching of components in the entire system from input signal to output at the shaker table.

INTEGRATED SYSTEM OFFERS OPTIMUM RESULTS

As the manufacturer of *complete* systems, MB intimately knows the operational needs of shaker, builds amplifiers and controls around those needs. Each MB system is integrated toward the highly desired end result . . . *delivering optimum performance at the shaker table* for present and future needs.

The largest field service organization in vibration testing is ready to help you achieve that result. For latest information, call on MB.

HIGH FORCE HIGH PERFORMANCE SYSTEM

Shown above is a typical MB test system. It includes a Model C70 7000 pound force vibration exciter fit for environmental testing chambers.

The MB T996 amplifier is rated at 50KVA output and can handle the most adverse reactive shaker loads for broad-band sine wave and random motion testing. The T68MC control console is easy to use, also provides automatically cycled testing. The T88 console expands system for complex motion work.

Send for Bulletin 470 which gives detailed specifications on the high performance available from this system; and from others to 25,000 pounds force.

largest producer of complete systems for vibration testing

MB manufacturing company **1055 State Street**
New Haven 11, Conn.
A Division of Textron Inc.

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when and where

DECEMBER

American Society of Mechanical Engineers, Annual Meeting, Hotels Statler-Hilton and Sheraton-McAlpin, New York, N.Y., Dec. 1-5.

Third EIA Conference, Reliable Electrical Connections, Dallas, Texas, Dec. 2-4.

Institute of Radio Engineers and American Institute of Electrical Engineers, Second National Symposium on Global Communications, Colonial Inn, St. Petersburg, Fla., Dec. 3-5.

Eastern Joint Computer Conference and Exhibit, Bellevue-Stratford Hotel, Philadelphia, Pa., Dec. 3-5.

Institute of Radio Engineers, Ninth National Conference, Professional Group on Vehicular Communications, Hotel Sherman, Chicago, Ill., Dec. 4-5.

Plas-Tech Equipment Corp., Symposium on High Speed Testings, Sheraton-Plaza Hotel, Boston, Mass., Dec. 8.

Mid-American Electronics Convention, sponsored by Kansas City Section, Institute of Radio Engineers, Municipal Auditorium Arena, Kansas City, Mo., Dec. 9-11.

American Astronautical Society, Fifth Annual Meeting, Hotel Statler, Washington, D.C., Meeting will be held in conjunction with the 125th Annual Meeting of the American Assn. for the Advancement of Science, Dec. 27-30.

JANUARY

Reliability and Quality Control in Electronics, Fifth National Symposium, Bellevue-Stratford Hotel, Philadelphia, Pa., Jan. 12-14.

Fifth Annual Radar Symposium (classified), Rockham Bldg., University of Michigan, Ann Arbor, Mich., Jan. 27-29.

Society of Plastics Engineers, 15th Annual Technical Conference, Hotel Commodore, New York, N.Y., Jan. 27-30.

Armour Research Foundation, Fifth Annual Midwest Welding Conference, Illinois Institute of Technology, Chicago, Ill., Jan. 28-29.

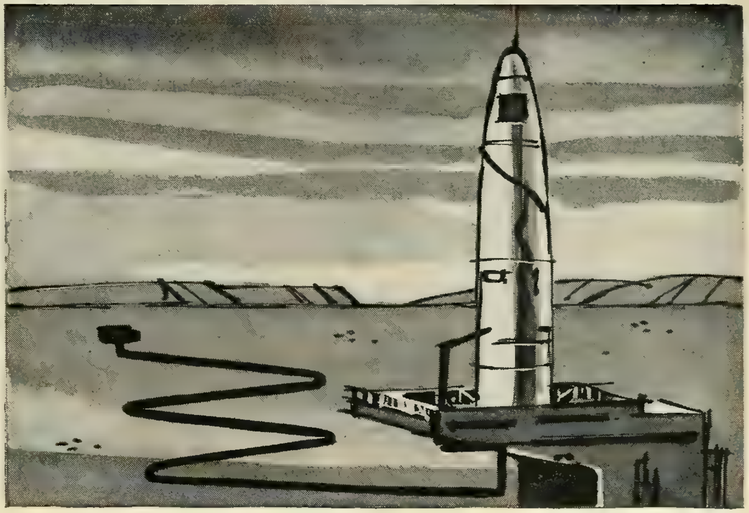
FEBRUARY

Society of the Plastics Industry, 14th Annual Technical and Management Conference, Edgewater Beach Hotel, Chicago, Feb. 3-5.

1959 Solid State Circuits Conference, Institute of Radio Engineers' Professional Group on Circuit Theory, American Institute of Electrical Engineers' Committee on Electronics and the University of Pennsylvania, Philadelphia, Pa., Feb. 12-13.

project:

FUELING MISSILES — FASTER



FRI develops successful automated hookup and couplings for fast LOX and fuel transfer

Here, the problem was 5-fold. (1) Develop a flexible coupling for automated hookup. (2) Prevent leakage. (3) Protect vital internal parts from icing. (4) Provide high flow with minimum pressure drop. (5) Keep weight to a minimum.

Flight Refueling, Inc. solved it. The long experience of Flight Refueling, Inc. in developing, testing and manufacturing lightweight aerial systems, and the recent experience of designing components for the transfer of hydrocarbon fuels, LOX, H_2O_2, N_2, mercury and other nuclear reactor coolants, as well as heated gases, has resulted in the successful completion of many unusual projects.

If you are concerned with *fast fluid transfer,* remember this—FRI has the engineering imagination to design complete lightweight systems, and manufacturing facilities to produce in quantities such components as valves, couplings, nozzles, fittings and portable tanks. Write for literature.

Flight Refueling, Inc.

FRIENDSHIP INTERNATIONAL AIRPORT • BALTIMORE 3, MD.

West Coast Representative: William E. Davis, Box 642, Inglewood, Calif.

Circle No. 25 on Subscriber Service Card.

Engineering problem:
Pressure-tight fastening of transit cases

The solution:
A specially modified LINK-LOCK

Applied Design Company engineers worked with Simmons to develop this successful LINK-LOCK application

Simmons LINK-LOCK, with design modifications developed in cooperation with the Engineering Department of Applied Design Company, Buffalo, New York, resolves special closure requirements in rigidly specified transit cases like the aluminum equipment container shown.

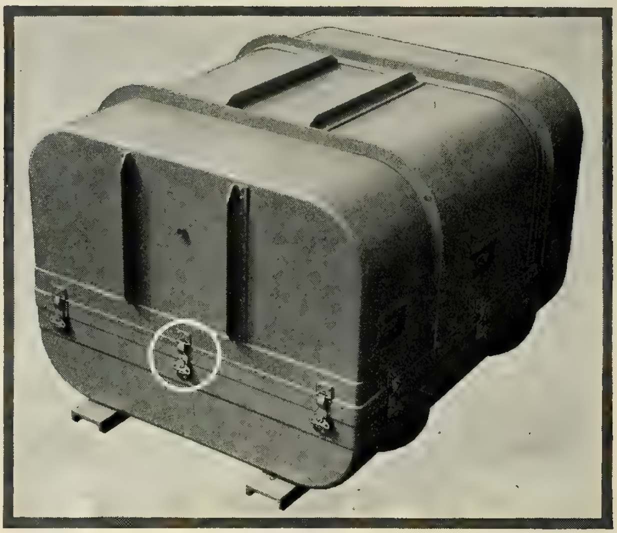
Here, the bowed LINK-LOCK engagement blade provides the double advantage of maintaining constant fastener pressure and permitting considerable mounting tolerance. This container is just one of many important products in which Applied Design specifies standard and special Simmons Fasteners.

Here's why LINK-LOCK is ideal for use on military cases produced to exacting specifications as well as on inexpensive commercial containers:

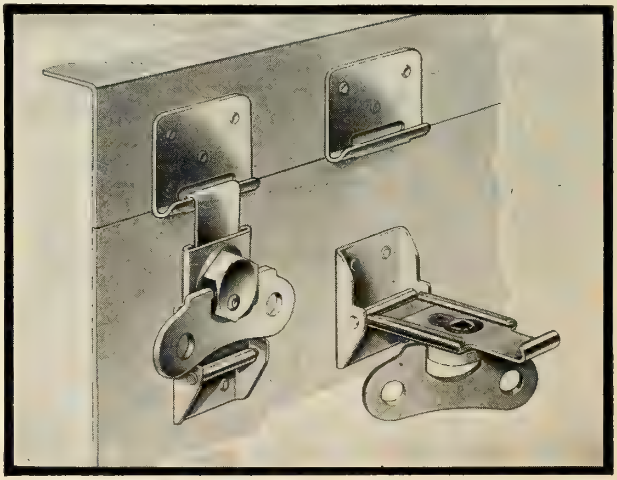
- Impact and shock resistant (positive-locking).
- High closing pressure with light operating torque... insures pressure-tight seals where required.
- Available in 3 sizes, for heavy, medium, and light duty.
- Compact design... lies flat against case even when unlocked.
- Opening and closing by wing-nut, screwhead, or hex nut.
- Flexible engagement latch design... can be varied to suit different conditions.

Also available: Spring-Loaded LINK-LOCK. Ideal for the less expensive containers where costs won't permit precision production. Spring provides take-up to compensate for set in gasketing, irregularities of sealing surfaces, and mounting inaccuracies.

SEND TODAY for the Simmons Catalog for complete information and engineering data on LINK-LOCK and other Simmons Industrial Fasteners. Engineering service is available; outline your particular fastening problems. Samples on request.



Twelve special loop-blade LINK-LOCK fasteners are used in this aluminum transit case designed by Applied Design Company.



Standard No. 2 LINK-LOCK (Medium-Duty). Available with screwhead, wing-nut as shown, or hex nut.

SIMMONS

FASTENER CORPORATION

1791 North Broadway, Albany 1, New York

QUICK-LOCK · SPRING-LOCK · ROTO-LOCK · LINK-LOCK · DUAL-LOCK · HINGE-LOCK

See our 8 page catalog in Sweet's Product Design File

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contract awards

ARMY

By the Department of the Army:

$1,570,000—**C. H. Leavell and Company** of El Paso, Texas for construction of *Nike-Zeus* developmental facilities at the White Sands Missile Range in New Mexico.

By U.S. Army Ordnance District, Los Angeles, Pasadena, Calif.:

$140,000—**North American Aviation, Inc.,** Canoga, Park, Calif. for design and development and $194,000 for rocket engines.

By Purchasing and Contracting Division, White Sands Missile Range, N.M.:

$58,288—**Nems Clarke Co.,** Division Vitro Corp. of America, Silver Spring, Md. for crystal controlled telemetry receivers and components.

$25,800—**Sperry Gyroscope Co.** Division, Sperry Rand Division, Great Neck, N.Y. for klystron tubes.

By the Office of the District Engineer, U.S. Army Engineer District, Baltimore, Corps of Engineers, Baltimore 3, Md.:

$129,500—**Keane Construction Co., Inc.,** Fort Lee, N.J. for special conversion for *Nike-Hercules,* Sites BA-18D-CL, BA-30D-C1 and BA-79D-C1, Maryland, consisting of new 8,000 gal. underground oil storage tank; elevator pump unit; government-furnished structural modifications to elevators, including locking bar supports, bolster, launching pad support, deck support beams, portland cement concrete pavement; security fencing and lighting.

By U.S. Army Ordnance Missile Command, Redstone Arsenal, Redstone Arsenal, Ala.:

$29,892—**Scintilla Division,** Bendix Aviation Corp., Sidney, N.Y. for electrical connectors.

$25,982—**Rome Cable Corp.,** Rome, N.Y. for guided missile test facilities.

$33,146—**Wiancko Engineering Co.,** Pasadena, Calif. for pressure pickups with varying ranges.

By U.S. Army Signal Supply Agency, Philadelphia, Pa.

$99,175—**Cornell University,** Ithaca, N.Y. for research work for 12 months to conduct a program of investigation and analysis of electron tube field failures.

$81,728—**Varian Associates,** Palo Alto, Calif. for research work for nine months covering a study of molecular and atomic resonance devices.

$59,822—**United Research, Inc.,** Cambridge, Mass. for research and development work for 4½ months on wind shear measurements.

$950,000—**Rheem Manufacturing Co.,** Aircraft Div., Downey, Calif. for redirection of work to be performed under the contract in the manufacture of 15 surveillance drones.

$95,413—**Hi-Q Division Aerovox Corp.,** Olean, N.Y. for research and development work for 18 months on transistor temperature compensation capacitors.

$75,382—**Radio Corp. of America,** Harrison, N.J. for research study of electron tube materials, gases, and getters, for 12 months.

$96,549—**Western Electric Co., Inc.,** New York, N.Y. for 12 months study to continue investigation of lutra-precise quartz crystal controlled oscillators, quartz crystal resonator.

By U.S. Army Ordnance District, Philadelphia, Philadelphia, Pa.:

$185,240—**Western Electric Co., Inc.,** New York, N.Y. four contracts for *Nike* spare parts and components.

$17,961—**The Trustees of the University of Pennsylvania,** Philadelphia, Pa., for determination of local magnetic fields and nuclear magnetic moments.

NAVY

By Supply Officer, U.S. Naval Gun Factory, Washington, D.C.:

$77,628—**Vickers, Inc.,** Waterbury, Conn. for repair parts, missile feeder MK 9-0, Handling BW-1 missile, hydraulic and electrical equipment for parts list R-23976-1.

$90,455—**Vickers Inc.** Electric Products Div., Saint Louis, Mo. for amplifiers, reactors, transformers, etc., to be used as spare parts for missile-launching system.

$74,110—**Associated Steel Co.,** Houston, Texas for stainless steel tubing various sizes for missile launcher MK 11-0 PML 12, 81,621 ft.

Bristol miniature pressure switch

features ultra-reliable precision pressure element. Exclusive design provides outstanding resistance to shock, vibration, acceleration and overpressures.

These Bristol miniatures, widely proved in modern aircraft, are designed for switching electrical circuits in response to pressure changes in air, fuels, lubricants, hydraulic fluids, other gases and liquids.

Bristol's specially designed Ni-Span element is silver brazed to the stainless steel base assuring greater reliability than ordinary soft-soldered construction. Result: accurate, reliable, repeatable performance in any position, at temperatures from —65° F to +250° F, and under Mil Spec environmental requirements.

Write for Bulletin AV2010 on Bristol Miniature Gage and Absolute, Adjustable and Differential Switches. The Bristol Company, Aircraft Components Division, 173 Bristol Road, Waterbury 20, Conn. 8.44

SPECIFICATIONS (Fixed pressure setting models)

Normal Working Range — 0 to 100 psi absolute, gage, or differential

Burst Pressure — exceeds 250% of normal working pressure

Electrical Ratings — 5 amp at 125 v, 60 cycle, inductive or resistive
4 amp at 30 vdc resistive
2.5 amp at 30 vdc inductive

Dielectric Strength — 500 v rms between terminals and from terminals to case (MIL-S-8801)

Life at Rated Electrical Load — 40,000 cycles at 125 vac
25,000 cycles at 28 vdc

High Temperature Exposure & Operating — (MIL-S-8801) 250° F

Low Temperature Exposure & Operating — (MIL-S-8801) —65° F

Shock, 30 g, 3 axes — (MIL-S-8801) no change

Vibration — (MIL-S-8801) no contact chatter, no switch damage
300-600 cpm at 0.050" d.a.—set point change—none
operating differential change—none
600-4500 cpm at 0.036" d.a.—set point change—¼ psi
operating differential change—½ psi
4500-30,000 cpm at 10 g—set point change—¼ psi
operating differential change—½ psi

Diameter—1-5/16

BRISTOL FINE PRECISION INSTRUMENTS FOR OVER 69 YEARS

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Engineers-EE, ME, Physicists

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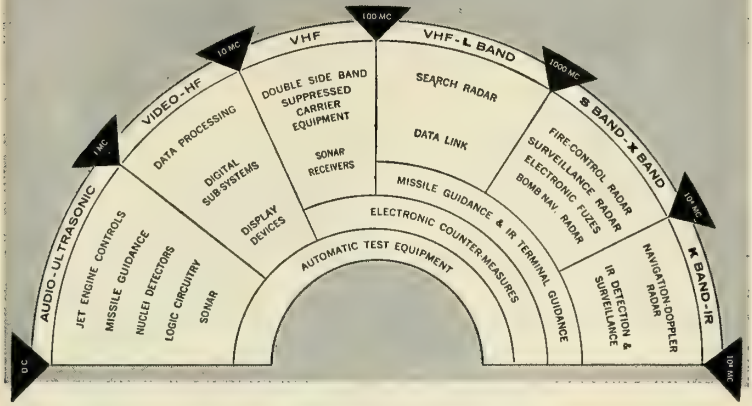

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Agency—Ron Coleman Agency
Bristol Co., The 59
Agency—James Thomas Chirurg Co., Inc.
Cannon Electric Co. 15
Agency—Anderson-McConnell Adv. Agency, Inc.
Consolidated Electrodynamics Corp. 49
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Dunham-Bush, Inc. 21
Agency—William Schaller Co., Inc.
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MB Mfg. Co., a Div.-Textron, Inc. 56
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Magnavox Co., The, Government & Industrial Div. 22
Agency—Rothbardt & Haas Adv., Inc.
Mallory-Sharon Titanium Corp. 3
Agency—The Griswold-Eshleman Co.
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Mayer's Grand Guide 40
Minneapolis-Honeywell Regulator Co., Boston Div. 6
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Nitrogen Div., Allied Chemical Corp. 24
Agency—G. M. Basford Co.
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Pacific Scientific Co. 43
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Simmons Fastener Corp. 58
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Standard Steel Works Div., Baldwin-Lima-Hamilton Corp. 8
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Telecomputing Corp. 52, 53
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Agency—Lennen & Newell, Inc.
United States Gasket Co. 55
Agency—The Michener Co.
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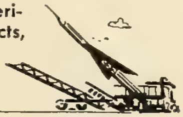

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We Will Deserve What We Get!

Americans who had taken to resting on their laurels were rudely awakened October 4, 1957—when man's first step into space was made by a Russian boot.

Reaction was first shock, then disbelief, then accusation. The Democrats blamed the Republicans, who in turn cited the years lost under Democratic administration when the groundwork should have been laid. Fingers were pointed at our education system, at our research and development budgets, and at our pleasure-bent philosophy of life.

For a while it looked as though the Russian boot had kicked us into action. Conferences were called, Congress held special hearings, experts were interviewed and aid-to-education bills poured into the Congressional hopper. The result was a fattening of the defense budget, passage of the National Defense Education Act—but not much else.

The temporary stimulus of the Russian kick has worn off. The public seems to have shrugged its shoulders and gone back to watching TV "adult" westerns. Meanwhile, the danger grows—despite, and in part because of, indifference.

One important facet of the problem that was early recognized but is still to be faced is the need for vigorous expansion of our science-engineer production (see m/r, Oct. 13, p. 19). And, although the number increases annually, the outlook is gloomy when these increases are evaluated in relation to the mushrooming demand of today's electronic era and tomorrow's atomic age.

A good start toward solution of the problem was made by the President's Committee on Scientists and Engineers. This pre-*Sputnik* group has been working quietly and effectively since April 1956 to coordinate and stimulate the efforts of private citizens to meet the growing scientific manpower need.

The PCSE, composed of 18 representatives from top industrial, scientific educational and labor organizations, has set up a series of effective programs in motion. These include analysis of scientific employment statistics, stimulation of interest in scientific and technical careers, steps to improve technical education and aid to industry for better utilization of the talent now available. The cooperation shown the PCSE groups by high schools, civic organizations, and manufacturers has been excellent.

Although this program was never meant to be a cure-all for the scientific manpower problem, projects such as the science summer day camps and the work of local committees have provoked a response and their effect has been tangibly felt. It is a small but significant step in the right direction.

However, with the need greater than ever, the Committee is scheduled to die at the end of this year. Although certain of the group's functions may be taken over by the Office of Civil and Defense Mobilization, just how it will operate and what phases of the work will continue are not clear. Furthermore, much of the group's effectiveness can undoubtedly be attributed to its prestige as a *Presidential* committee. And although PCSE has been *of* the government, it was not *by* the government. This distinction is sure to be lost if it is slipped into some niche in an independent government agency.

Last May, the Committee voted unanimously to continue in operation for another year. The White House compromised with a six-month extension. Among those groups who strongly favored that the committee continue "as is" were such participating members as the U.S. Chamber of Commerce, the National Society of Professional Engineers and the AFL-CIO. Representatives of those organizations have been vocal in their keen disappointment that the team cannot continue their projects as planned.

Included in those programs whose fate is still in doubt is the evaluation of statistical data to determine as accurately as possible what the future demand and supply of scientists and engineers will be. Such a study would be extremely useful to the future planning of industry.

Although the White House admits the committee has "served a useful purpose," reason given for the change is that the group was never intended to be permanent and that "most of its work has been graduated into major and permanent projects" which will be largely directed by Presidential Scientific Advisor Dr. James Killian and the OCDM.

However, the wisdom of this still vague move to "graduation" is questionable when the committee has functioned so well, accomplished so much, has projects still to complete and is itself, unanimously in favor of continuing its status quo.

Its effective impact on an apathetic public opinion in those towns and cities where its programs were introduced has proven that there is need for not only a continuation of the work started, but for an expansion.

We know what the committee can do because of what it has done. Why disrupt it now?

If programs such as the PCSE are allowed to wither away at a time when their need is increasingly urgent, we may have to take the consequences of having been not only "hauled kicking and screaming" into the atomic era but of being completely inadequate to cope with it when we get there. And we will deserve what we get.

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DES. The availability of silicon er Regulator Diodes in both 10 watt 50 watt power ratings with voltage jes up to 200 volts have been anced by Motorola's Semiconductor sion. The 10MZ series which is rated 10 watts at 55°C is housed in the c, standard 10-32 stud package, e the 50MZ (50 watt) series uses TO-3 package with either plug-in solder-in features as well as series lock construction for protection nst overvoltage on load. Both Zener lator families are available with er anode or cathode connected to for maximum circuit flexibility.

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TAPE SYSTEM. Tele-Dynamics Inc. announces a new all-electronic Tape Error Compensation system for the reduction of wow and flutter errors in telemetry tape record-playback systems. Error frequencies of up to 3 Kc with magnitudes as great as 50% of design bandwidth for all IRIG subcarrier bands, both narrow and wide, are corrected by a minimum of 20 db. Subcarrier channels operated in either the continuous, commutated, or on-off modes may be corrected. Composed of three ruggedized modular components, the system weighs 35½ lbs. and occupies 5-7/32 in. of panel space in a 19-in. equipment cabinet.

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AMPLIFIERS. A series of miniaturized DC Amplifiers, having adjustable voltage gains of 100 to 500 with a linearity of plus or minus .5%, based on a 5 volt DC nominal output value, have been announced by Networks Electronic Corp. The units weigh approximately 7 ounces and measure 2.5" x 1.19" sq.

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26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

• • Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

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225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
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FACILITIES. The Sundstrand Turbo Div. of Sundstrand Machine Tool has available a new thirty-six-page brochure, "Capabilities and Facilities." The publication covers the company's departments of Research and Development, Testing, Production and other general information. Some of the specific research and development catagories listed are: chemical, metallurgical, mechanical, electrical, cryogenics, hydraulics and combustion.

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126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150
151 152 153 154 155 156 157 158 159 160 181 162 163 164 165 166 167 168 169 170 171 172 173 174 175

• • Missile Literature

200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224

• • New Missile Products

225 225 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249
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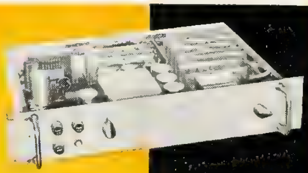

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This issue:

AMERICA'S SPACE PROBE PROGRAM FOR '59

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

News and Business Edition

AN AMERICAN AVIATION PUBLICATION

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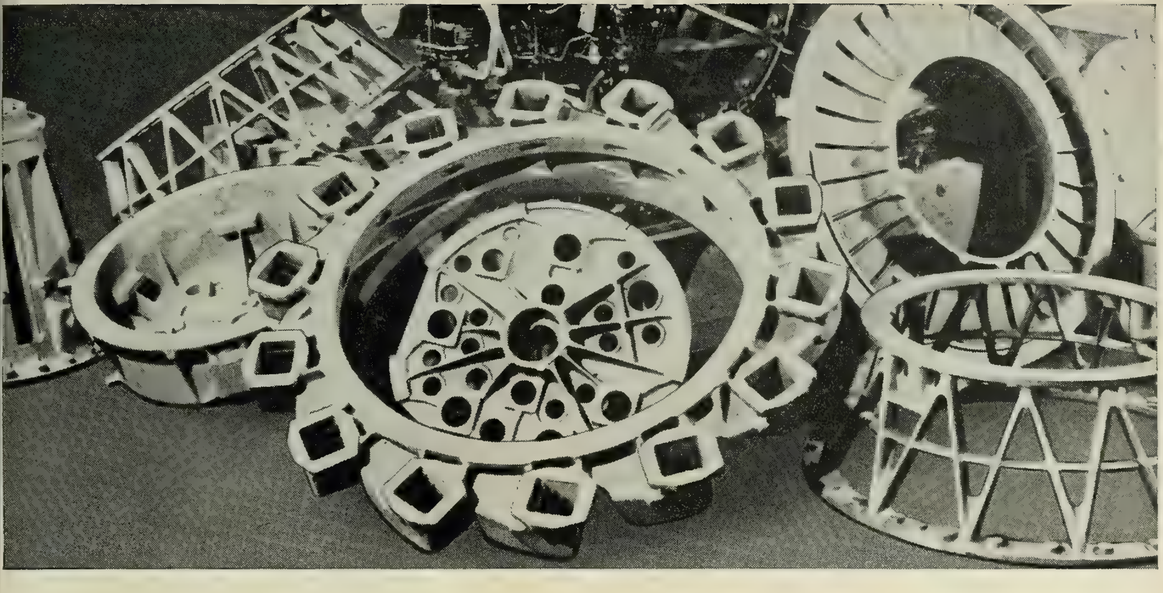

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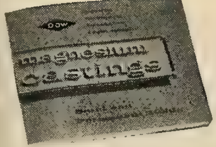

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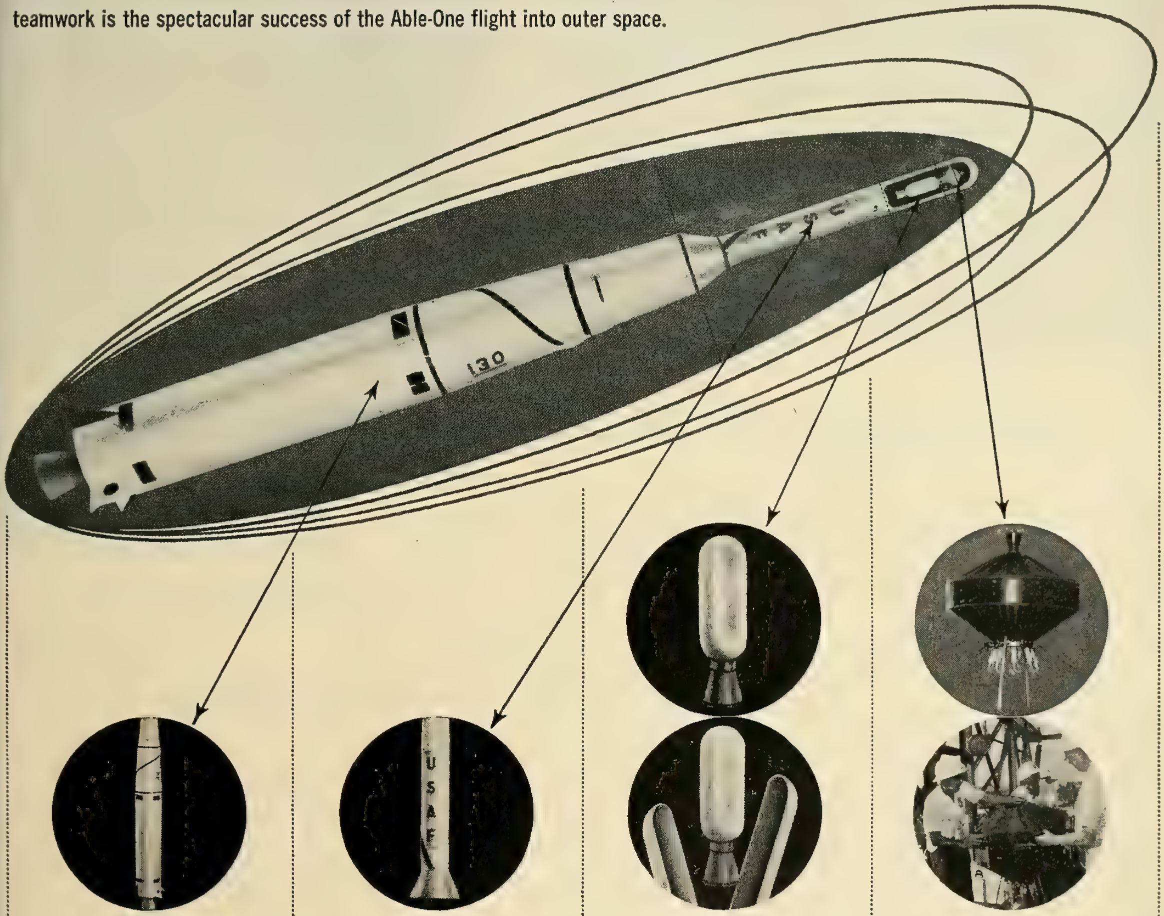
Preparation and execution of an undertaking such as the United States' IGY space probe demanded the participation and exceptional efforts of 52 scientific and industrial firms and the Armed Forces. The Advanced Research Projects Agency and the AFBMD assigned Space Technology Laboratories the responsibility for the project which was carried out under the overall direction of the National Aeronautics and Space Agency. One measure of this teamwork is the spectacular success of the Able-One flight into outer space.



1st stage: Vehicle, Douglas Aircraft **Thor** IRBM; propulsion, Rocketdyne; airframe, control, electrical and instrumentation, Douglas Aircraft; assembly, integration, and checkout, Douglas Aircraft.

2nd stage: Propulsion system and tanks, Aerojet-General; control, electrical, instrumentation, accelerometer shutoff, and spin rocket systems, STL; assembly integration, and checkout, STL.

3rd stage: Rocket motor, U. S. Navy Bureau of Ordnance and Allegheny Ballistic Laboratory; structure and electrical, STL; assembly, integration, and checkout, STL; ground testing, USAF's Arnold Engineering Development Center.

Payload: Design and production of **Pioneer,** the payload of the Able-One vehicle, was conducted by STL in addition to its overall technical direction and systems engineering responsibility of the Air Force Ballistic Missile Division project. This highly sophisticated package included a NOTS TV camera and transmitter and Thiokol rocket motor.

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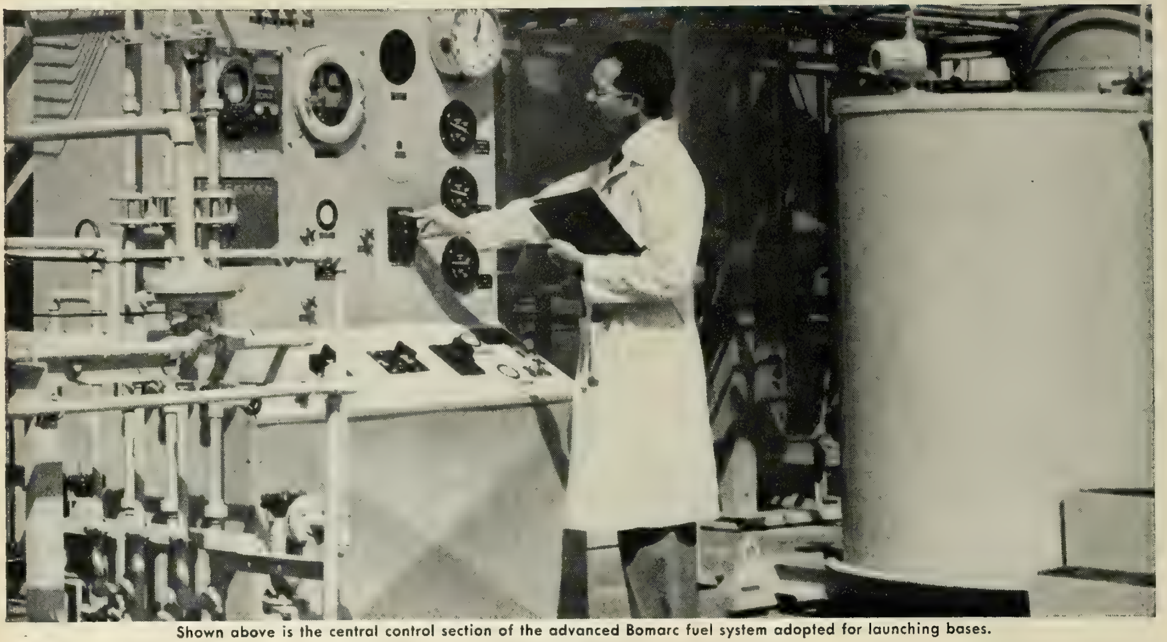
...speaking of Missile Ground Support ***EQUIPMENT***



Shown above is the central control section of the advanced Bomarc fuel system adopted for launching bases.

WE PROVIDE PROPELLANT HANDLING SYSTEMS

FMC is one of the few companies in this country that is capable of offering coordinated mechanical and chemical experience combined with design, engineering and production facilities devoted exclusively to building advanced missile ground support equipment, under single responsibility.

Under a contract with Boeing, for example, FMC's Ordnance Division conceived, designed, engineered and built this complete support system for the long-range Bomarc interceptor missile.

Technical assistance on this important defense project was provided by FMC's Westvaco Chlor-Alkali Division. This chemical group is experienced in producing missile propellants such as *Dimazine* (unsymmetrical dimethylhydrazine) one of the propellants used in the Bomarc.

In the design and production of defense materiel, FMC's background extends over more than 17 years. Also, FMC has long been recognized as a leader in the chemical field. This broad experience, supported by Ordnance Division's completely integrated facilities devoted exclusively to the manufacture of military equipment, can be applied to your missile project — from design concept through development, engineering and production, to on-schedule delivery.

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COVER: *A meteor makes a spectacular path across intergallatic space in this time exposure, representative of the second year in the Space Age. Details of the United States' space program for next year are given in an exclusive article on page 19.*

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in this issue

DECEMBER 8 HEADLINES

The U.S. Space Program for 1959
Exclusive m/r report outlines *Fledgling* satellite program; MIS, *X-15* tests; future *Vanguard* experiments, interplanetary probes; lunar program; *Baby Sentry* satellites, and military Man-in-Space ..**19**

Huntsville: From 'Cotton' to 'Space'
President's decision on transfer of Army missile talent to NASA administration is awaited with concern and even anxiety **27**

Pacific Missile Range Could Cost Billions **43**

ASTRONAUTICS ENGINEERING

***Purr-Kee*, AMF's Versatile Sounding Rocket**
Scientists are making important use of this research tool every day **22**

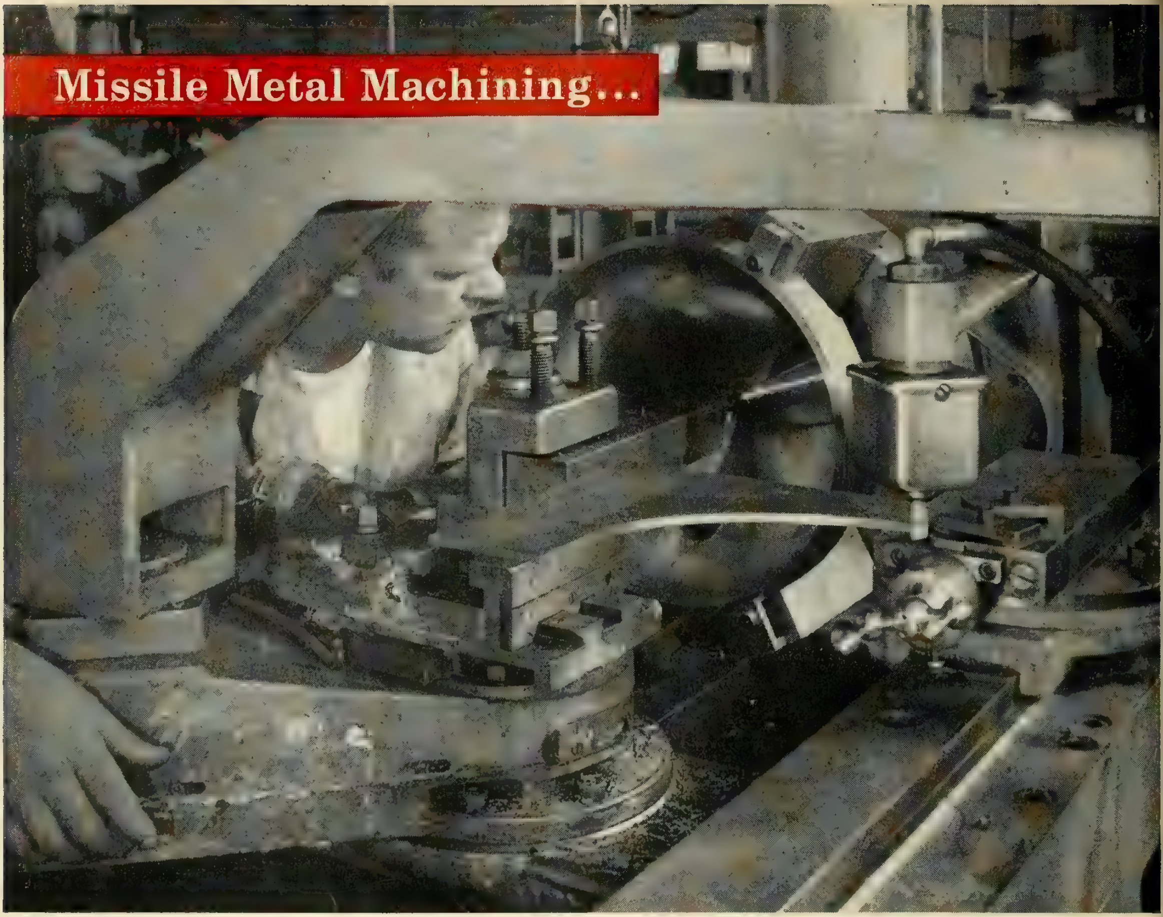
MISSILE ELECTRONICS

Direction Finder May Alter Alinement Concepts
NAA Autonetics' portable device could replace conventional methods of determining azimuth-reference base lines **35**

Magnetic Unit Uses Extremely Low Power
National Cash Register glass rod switching and storage element is so fast that top speed is unknown **39**

DEPARTMENTS

In My Opinion 9
Washington Countdown 15
Industry Countdown 17
When and Where 49
Propulsion Engineering 49
Contract Awards 50



FROM BLANKS TO BULKHEADS!

The Diversey craftsmen above is machining the inner diameter of a Forward Bulkhead of the Hawk missile to a fine 63 microinch finish. Notice the precision curved template in the center of the picture with the follower at the right end transferring the contour to the interior of the bulkhead. Another good example of the famous air gage tracer lathe technique that has brought the missile hardware field to such an advanced state.

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FROM NOSE TO NOZZLE, FROM FIN TO FIN, CONTOUR TURNED PARTS—WITH PRECISION BUILT IN

In My Opinion . . .

. . . the recent cancellation by the Navy of a follow-up order for *Seamaster* aircraft—and the probable layoff of 6,000 employees at Martin-Baltimore—points to a severe industrial problem that will be repeated many times in the future unless we do something about it now.

The Martin cutback is undoubtedly the first in a series of Department of Defense streamlining attempts for aircraft and missile systems development. There will have to be a choice between the *Jupiter* and the *Thor,* the *Atlas* and the *Titan* and possibly many other extensive and expensive programs. Cancellation of these programs could mean personnel lost at a time when the National Aeronautics and Space Administration is searching desperately for manpower and facilities to get U.S. space programs off the ground.

In an editorial one year ago (m/r Nov. 1957, An Open Letter To President Eisenhower) we recommended that the Administration take immediate steps to plan ahead for the missile teams that will not be needed once our research and development programs mature. We said: ". . . There is a sound solution. If *Thor* proves to be the best weapon of the two IRBMs, do not cancel out the *Jupiter* team and money as a total loss, but shift the team and its hardware to America's inevitable space flight program. Special configurations of the *Jupiter*—or the *Thor*—are capable of putting up satellites of 1000 pounds weight. We could achieve this within months. Either missile represents a valuable piece of hardware for practically any preliminary space flight project. With this approach we can catch up with the Russians two to three years sooner—without slowing our military program—than if we repeat the approach we used in developing the *Vanguard* "me too" satellite.

"The same technique can be used with our *Atlas* and *Titan* ICBMs. The missile not selected as a weapon must enter our future arsenal of space vehicles. So must the scientific team behind that missile.

"Employing this approach, we will save the taxpayers millions, possibly billions, of dollars. The decision to pursue this goal and employ this technique must be made now."

This was one year ago. In the meantime, nothing has been done about this inevitable problem. Convair, Martin, Douglas and Chrysler—and their thousands of subcontractors—must have assurance that their products and personnel be utilized. If one missile is chosen over another as a weapons system, clearly the other effort should not go to waste. Space probes using the non-military rocket are called for in the best interests of peaceful exploration of space.

It appears that here is a chance for the Department of Defense and the NASA to prove that they have "togetherness" and that our invaluable missile manpower and know-how will be used fully in our space program in case of military cutbacks.

Industry itself has put millions of dollars into the training and education of missile personnel. The government is obligated to put a serious effort into preservation of this asset at a time when we're in a struggle for survival. This is an area where DOD and NASA must decide together for the benefit of the country, our missile and space programs—and for the benefit of industry and its valuable missile men. Failure to do so would be catastrophic.

Erik Bergaust

crimp-type

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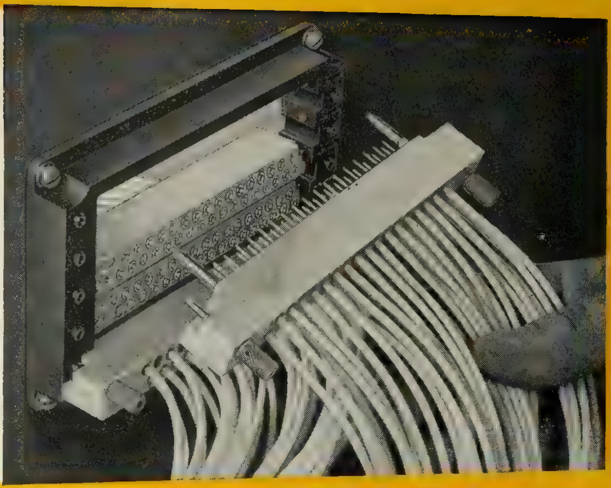

quick-disconnect or permanently connected

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with snap-in, spring-loaded contacts

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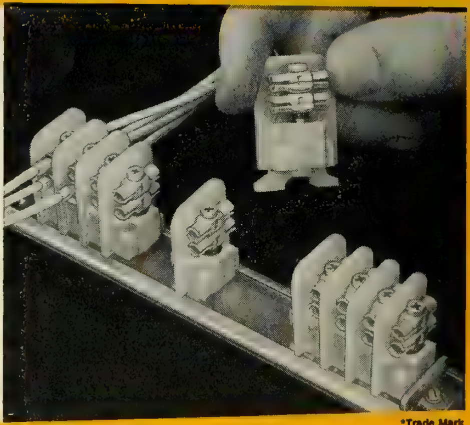
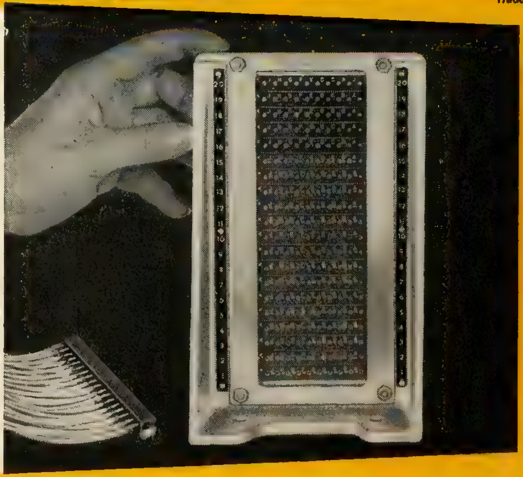


*Trade Mark

crimp-type, solid-shank

STAPIN® **taper pin contacts**

Another Burndy contribution to the modular concept of assembling standard units to provide custom-fitted end products.



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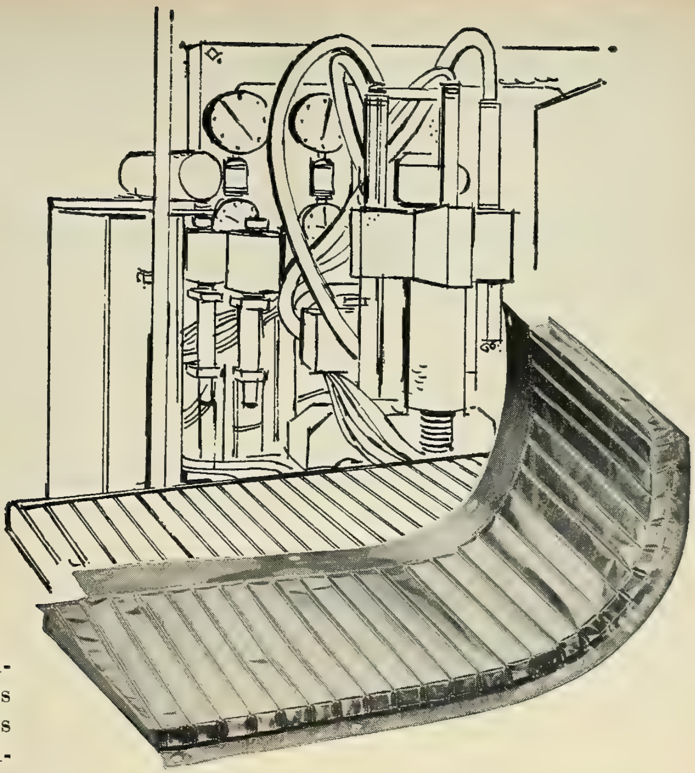
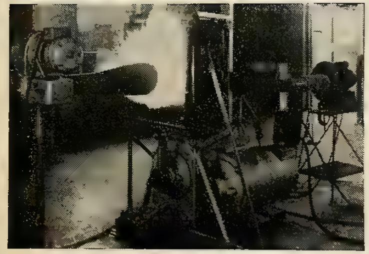


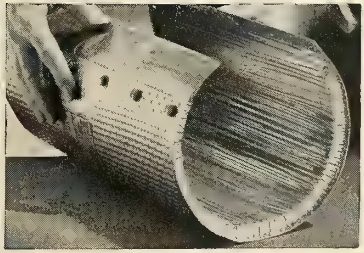
Leaders in the aircraft and rocket industries look to L·O·F Glass Fibers Company for the new developments in both thermal and acoustical insulating components, because this is the *only company in the glass fiber field* that performs all of the following:

> starts with the sand . . . turns it into glass . . . draws it into fibers . . . forms them to specification . . . covers them with metal or plastic in custom fabrication.

L·O·F Glass Fibers Company fabricates insulation for thermal applications (up to 3000°F.) and a wide range of acoustical applications, including: de-icer duct insulation, tail-pipe and afterburner insulation, turbine case insulation, engine parts insulation, hot-air duct insulation, cabin-heater duct insulation, cabin insulation, structural insulation and bleed-air duct insulation.



Insulation blanket made with ½ inch of Micro-Quartz felt withstands the searing heat of a 2000°F. flame.



Wrap-around blanket, encased in stainless steel, shields hot-air duct at 600°F. Insulation will not pack, settle or crumble.

New Micro-Foil tape, made from Micro-Quartz felt faced with aluminum, protects parts too small for molded or shaped insulation.

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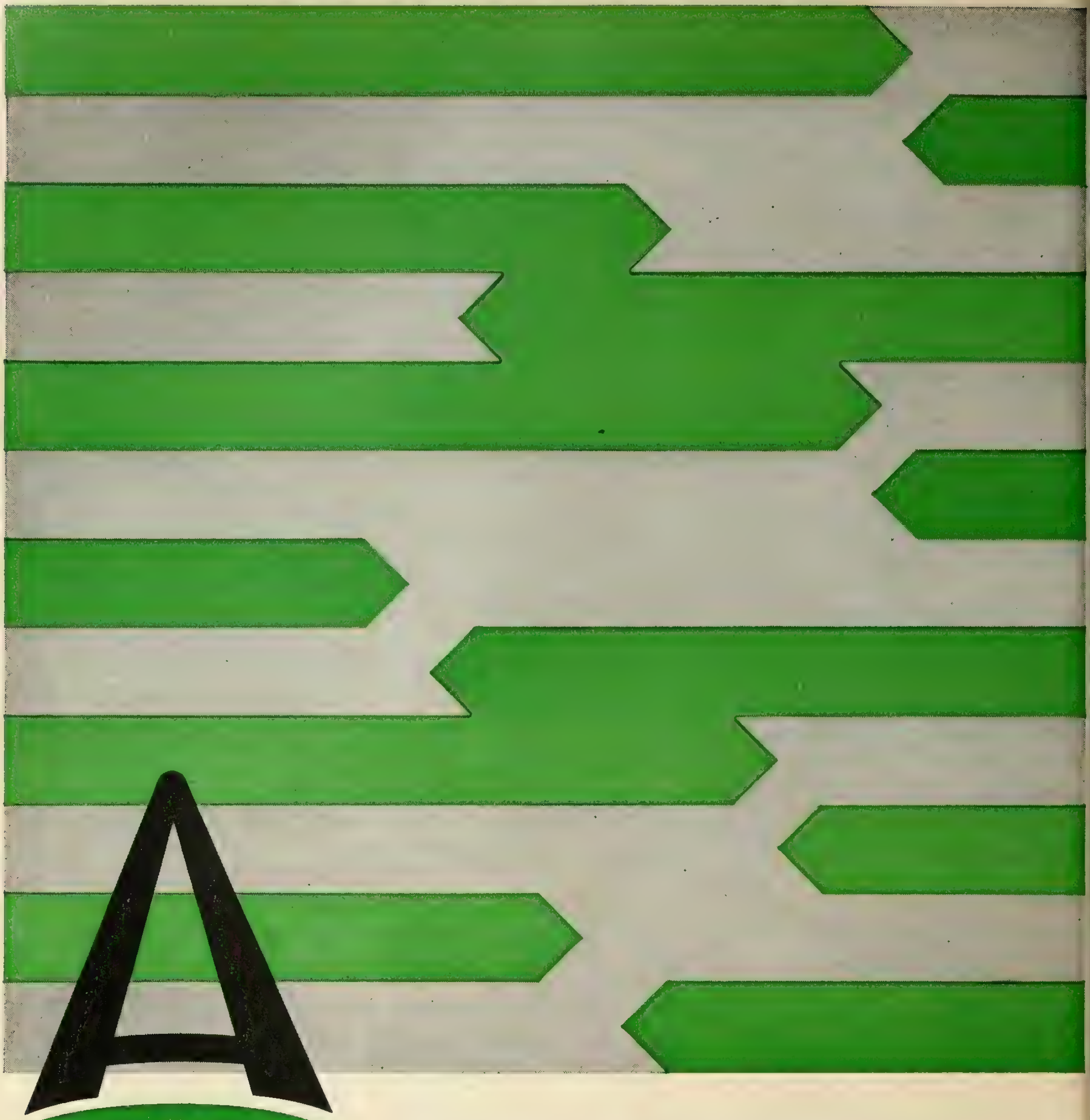

ASTRODYNE —aimed for the future in solid rocketry

Astrodyne was founded early this year to bring together in one productive group all the skills, experience, and facilities it takes to design and manufacture America's major solid propellant missile systems.

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McGREGOR, TEXAS

Ryan Firebee

jet drone missiles

are flying longer, farther, higher, faster on target missions—and more of them "live" to fly another day.

For example, at Vincent Air Force Base recently, the 4750th Drone Squadron launched 44 Firebees *in a row,* which averaged one hour's flight duration each. And 39 of them—many after target "hits"—were recovered successfully for re-use!

Other Firebee firsts: the one that completed 19 missions; the one that flew 1 hour, 42½ minutes; the one that made a flight 152 miles away from ground control and returned to be recovered in a pre-selected area; the drones that regularly fly target missions at Mach .9; and the *production* "birds" that have flown above 50,000 feet.

An elusive, pilotless plane, the Ryan Firebee is the most widely used jet target in training operations . . . the most realistic stand-in for "enemy" aircraft. That's why the Firebee is used as the target for such weapons as the Air Force Falcon and Genie; Navy Sidewinder, Sparrow, and Terrier; and Army Nike. That's why the Firebee was the exclusive target drone used in the Air Force's recent Project William Tell to evaluate the combat readiness of America's air defense system.

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MISSILE DIVISION
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washington countdown

SeaMaster cutback . . .

was only the first of several weapon system reductions, which has the missile industry worried and hopeful that NASA will move in and tighten up the cinches. Industry is thinking of *Atlas* vs. *Titan* and *Jupiter* vs. *Thor*. And if one is chosen over its counterpart as the weapons system (see editorial, p. 9), it would then be logical for the other missile systems to be used in space probes.

Presidential decision . . .

on NASA's request to take over certain service facilities, including ABMA and JPL functions, was expected to have been made as m/r went to press. NASA, unofficially, reportedly also wants in on Aviation School of Medicine, Naval Test Station at China Lake, Calif., and Signal Corps Laboratory at Fort Monmouth, N.J. Huntsville, meanwhile (see p. 27) is anxiously awaiting a decision of the president's Space Council on the ABMA decision.

Provocative book, Spacepower . . .

nine months ago forecast what would happen in the UN regarding control of space. Book accurately predicted that a joint committee of nations (without Russia if it failed to cooperate) would be set up to study plans for a permanent UN Space Agency.

The $40 billion question . . .

facing President Eisenhower and his budget advisors is getting a thorough going over. Details can be polished as late as Christmas, but the bulk of the "best seller" must go to the printer's by mid-December. Big question is how stringently the White House will attempt to impose the overall government budget reduction on the military departments. Defense Appropriations Subcommittee Chairman George Mahon has estimated a minimum budget of $42.5 billion. Being decided are what missile programs will be dropped and just how much emphasis will be placed on the anti-missile missile.

Anti-ballistic missile defense . . .

thinking in the Air Force does not rule out the concept of manned space vehicles as launching platforms for anti-missile missile. This is area defense with a vengeance.

70 Electronic technicians . . .

are required to maintain one ballistic missile squadron *(Thor, Jupiter, Atlas* or *Titan),* just about 10 times the number required to maintain a squadron of F-80s, the first U.S. jet aircraft.

House Armed Services Investigation . . .

Subcommittee headed by F. Edward Hebert (D-La.) latest probe concerns unused facilities of the Armed Services and DOD's standardization program. Not scheduled are weapons system management and the "team concept" of defense buying, although Washington sources say that these items will be taken up later this month.

Another House group . . .

The House Armed Services Subcommittee on Manpower Utilization, is looking into whether or not scientists and engineers are being effectively employed in the U.S. missile program. The subcommittee is chaired by Rep. James O. Davis (D-Ga.)

Successful full-distance launch . . .

of *Atlas,* contrary to publicity, does not put U.S. on par with Russia in ICBM development. Prospects are that Russia made its full distance ICBM tests many months ago. Convair is stepping up *Atlas* tests.

Dedicated Teams . . .

continue to be a big factor in the missile success this nation has enjoyed, Dr. Richard B. Morrison, former test director of the *Thor-Able* recovery program told Detroit audience many on the *Thor-Able* team worked 100-120 hours per week, although their pay checks were only for 40 hours.

First *Titan* firing . . .

is scheduled from Cape Canaveral for mid-December. This initial shot will be for stability, and is destined to travel about 400 miles if successful. As in the first *Atlas* firings, probably only one engine will be used and much of the guidance will be omitted. Second stage probably will not be fired.

BURROUGHS SYSTEMS STUDIES PLAY A VITAL ROLE IN DEFENSE

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Burroughs Corporation

"NEW DIMENSIONS / in computation for military systems"

industry countdown

Accumulated data on beryllium . . . is available in one volume from the Office of Technical Services, Department of Commerce. Prepared by the Defense Metals Information Center of the Battelle Memorial Institute, the report includes data on sources, extraction, production, fabrication, properties, and applications.

Giant dry hydrogen furnace . . . for vertically brazing assemblies as big as 10 feet by 6 feet in diameter has been developed by the Stainless Process division of Wall Colmony Corp. Furnace can be used for controlled-atmosphere brazing, heat treating, annealing with pure dry hydrogen, argon, carbon dioxide, nitrogen, or exothermic gases.

Jobs for scientists and engineers . . . will increase greatly in next ten years, a survey made by Scientific Apparatus Makers Association, shows. Top executives of 500 large firms estimated rises of 25%.

Lockheed MSD has purchased . . . 154 acres of the Holthouse ranch next to its Sunnyvale facility for future expansion. Original size of Sunnyvale was 275 acres but Lockheed also recently added about 16 acres bordering on its east boundary.

Speaking of Lockheed . . . the company said that missile sales in 1959 will amount to 35% of total volume. Projection is that this will rise to 40% in 1960 and 45% in 1961. The *Polaris* and *Sentry* programs, both among the first six in DOD priority, are the company's top programs.

Contract for the *Titan* . . . launching system has been awarded to American Machine and Foundry. The $29 million-plus program is for design and development of an underground launching system, the so-called "hard" base for *Titan.* AMF's Greenwich (Conn.) Engineering Division, already at work on the launching system for several months, will handle the program.

New type of glass . . . which turns temporarily opaque in proportion to the light impinging on it, reportedly has been developed by National Cash Register Co. The special chemical coating opaques the glass by joining molecules together. Company reportedly has no problems, but says clearing still takes too long to be practicable. Uses in space would be many, including shielding from solar rays when a vehicle faces the sun.

A new day has dawned . . . in rocketry with the announcement by Aerojet that it would merchandise (on an off-the-shelf basis) the British-made Napier *Scorpion* liquid fuel engine. This will be the first time that a fully-developed liquid-propellant rocket will be available from stock. The *Scorpion* is a twin-chambered unit using hydrogen peroxide and jet fuel and has a thermal ignition system.

Navy has approved . . . the *Gimlet,* a new air-launched, five-inch folding fin rocket, for operation. The solid propellant will be used by attack aircraft. Hunter-Douglas of Riverside, Calif. has a $2 million contract for aluminum rocket motor tubes, but the *Gimlet* is not yet in full production.

Metal forming by explosion . . . is being developed by Aerojet. In the process, a metal mold is backed in concrete and the blank material to be formed fastened above. Aerojet then pulls a partial vacuum and an explosive change is installed above the blank. The whole unit is submerged in water and then detonated. Process has already proved effective with metals of thickness from 0.012 to 2.0 inches thick.

Looks Like the *Navaho* . . . is really dead this time. AF spokesmen said that the North American weapon, long-since cancelled, will no longer even be used as a research vehicle for high-speed, high-altitude vehicles. Possibility of getting the same data by "more conventional methods" including wind tunnels was given as the reason.

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missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

Second Year of Space Age:

Nation Scurries to Catch Up

But while there's below-the-surface dissention between agencies, many promising programs are being developed for Man-in-Space: Interplanetary probes to Mars and Venus; Project *Fledgling;* more *Vanguard* experiments; *X-15* tests; lunar exploration; reconnaissance satellites; and use of *Titan* and *Pershing*.

By Erik Bergaust
and Norman L. Baker

WASHINGTON—An impressive array of projects has been planned for the second year of the space age, ranging from man's first venture into near space to the projection of small unmanned payloads to the vicinity of Mars and Venus.

Many will probably succeed even though the United States, hurrying frantically to catch up in the race for space, has scheduled a program which is almost certainly suffering from management problems and rivalries in the agencies responsible for carrying that program out.

The major problems, as reported to m/r:

1) NASA, after starting boldly, is now moving over-slowly in its unpopular program to recruit the qualified personnel it must have.

2) The old hauling and pulling of inter-service rivalries continues to plague ARPA.

3) Below the surface dissention has developed between NASA and ARPA, mostly as a result of indecision of roles and missions in border-line areas of authority. ARPA does not want to fund any project that NASA may later take over. NASA wants more information from ARPA.

4) Army is being hamstrung by a growing lack of cooperation between its ABMA and JPL.

5) Several of ABMA's advanced propulsion research projects are being cut, including ion propulsion and high energy fuel, such as chlorine trifluoride and ionized hydrazine.

6) JPL wants to handle all the scientific space work, including the handling of the rocket vehicles, designing and assembling payloads, and operating the tracking facilities. JPL feels it is better qualified in this field than ABMA. Twenty-six million dollars of NASA's budget, planned originally for ABMA, will be awarded to JPL.

Regardless of the reported conflict between the agencies, business within the space industries can expect a sizeable upswing during 1959. In fact, the first impact should be felt within the next 30 days.

- **Project** *Fledgling*—Invitations to bid on NASA's latest satellite program, Project *Fledgling,* will be sent to industry near the end of the month. *Fledgling* will be sent into orbit 5-15,000 miles out for investigating the composition of the sun and the extreme upper atmosphere.

Tentative plans call for 12 satellites to be launched during the program. The *Vanguard* first stage rocket, which many experts consider a highly reliable system, and an advanced *Sergeant* would be used for boosting the *Fledgling* payload into orbit. The advanced *Sergeant* is still in development.

The *Fledgling* program will have various highly-advanced payloads. Some will have instruments to investigate the composition of the sun while others will measure conditions in the vicinity of the earth.

Those for solar investigation will be equipped with spectrographs for more accurate recording of the spectrum. For instance, the calcium line will provide scientists with additional information on the composition of the sun's interior. The satellites, in the sun's light for more than 60 minutes of each orbit, will be equipped with sun-following devices to keep the recording instruments exposed during this phase. A sun-follower device was first used on a *Viking* research rocket flight years ago.

Other *Fledgling* satellites will measure the densities of the ion "clouds" near the earth. The ion "clouds" con-

Variety of Space Probes Planned for 1959

Here are United States space programs for the coming year in capsuled form:

Project *Fledgling:* Tentative plans call for 12 satellites to be launched during the program to investigate the composition of the sun and the extreme upper atmosphere.

MIS Program: First test operations next summer with closer look being taken at Army's original Project *Adam* program.

X-15 **Tests:** First flights with Scott Crossfield at the controls are scheduled for February.

Vanguard **Experiments:** Cloud cover Army Signal Corps satellite; repeat of SLV-3 for investigating variation in light intensities reflected from the earth; satellite for measuring magnetic field flux of the earth; 70-pound payload satellite; "hot" *Vanguard* with liquid ozone added.

Mars-Venus Probes: Three or four attempts planned with first Mars probe in late February, followed by remaining shots in March or April.

Use of *Titan:* ICBM booster under consideration for one Mars project with a "hot" third stage.

Juno **IV:** Under development for interplanetary flights.

Lunar Program: Expansion expected beyond the two Army and three Air Force attempts with NASA reportedly having ordered several *Pioneer* and *Juno* II vehicles.

Explorer: No plans for continuation beyond launch of 100-foot inflatable sphere.

ARPA Man-in-Space: First will be to orbit and recover chimpanzee capsule. Special use of Army *Pershing.*

Baby *Sentries:* Nine test payloads of 200-400 pounds into polar orbits. *Atlas* C or D to orbit about 12 payloads up to 4,000 pounds.

sist of ionized atoms concentrated hundreds of miles from the earth by the magnetic field.

Polarizing telescopes will be utilized in an attempt to track air currents near the surface of the earth. Scientists feel that layers of static and moving air currents can be differentiated with polaroid instruments to aid world-wide weather forecasting. Surface temperatures will be measured with bolometers in the far-infra-red band of the spectrum.

Decision to use the *Sergeant* for the second stage of the *Fledgling* launching vehicle has raised the problem of guidance selection. System to evolve may be similar to the *Polaris* second stage guidance and control system. Final cutoff will be accomplished by ground control.

• **MIS program**—NASA's man-in-space program, initiated last month, will start first testing operations late next summer. The Army's Project *Adam* (m/r, June, p. 40) is reportedly being re-evaluated for man's first ballistic missile ride into space in connection with the manned capsule program. The *Redstone*, unquestionably the most reliable heavy ballistic missile-available, is deemed the only booster safe enough for manned flights for months to come.

Ballistic flights will be made from Cape Canaveral to an altitude of 90 miles and 200 miles down range. Capsule, to be recovered by parachute, will be similar to NASA's preliminary specifications (m/r, Nov. 10, p. 13). Meanwhile, many of the space capsule bidders have teamed up in an effort to obtain a technological advantage in anticipation of the development contract to be awarded shortly after the first of the year. Convair, producers of the *Atlas* booster to be used in launching the later orbiting manned space capsule, is reported a good bet for the system prime contract.

• *X-15* **tests**—The Air Force's man-in-space vehicle, *X-15*, will make the first flight test in February with Scott Crossfield at the controls. Using the eight-barreled rocket engine, installed until the Reaction *Pioneer* engine is delivered, Crossfield will check out flight characteristics. Record flight with 50 k engine and flight to the limit (100 miles altitude and 3000 mph plus) will not be made by an Air Force pilot until summer of 1959.

• **Proposals surveyed**—The Space Science Board of the National Academy of Sciences in cooperation with NASA is surveying hundreds of satellite proposals that have come in since NASA's formation. From these proposals, detailed experiments are being formulated and plans laid for a program that will extend years into the future. However, for the time being, NASA is concerning itself with satellite experiments that will be left uncompleted at the end of the IGY year.

The IGY satellite program fell short of expectations as the result of launching vehicle failures. This forced many experiments of vital importance to be postponed or cancelled. The majority of these experiments have been acquired by NASA and will be the first ones carried out in the near-space satellite launchings.

• *Vanguard* **postponed**—*Vanguard*, originally conceived as the United States' sole satellite launching vehicle during the IGY, after suffering one setback after another since its unfortunate test vehicle attempt a year ago, has been moved into NASA's space plans. Firing schedules will be stretched out with launching dates more relaxed. Under NASA's new schedule, the first of four remaining shots will go in February while the final shot may pass over into 1960.

Experiments planned for the remaining *Vanguard* shots include:

1) Satellite built by the Army Signal Corps containing a photo-electric cell for studying the earth's cloud cover. Weight of payload, 21.5 pounds. This one is slated for the February launch.

2) A repeat of SLV-3, the last unsuccessful firing. This satellite will be equipped with instrumentation for investigating the variation in light intensities reflected from the earth. A photo-sensitive cell will trigger the instruments into operation when the satellite is over the light side of the earth.

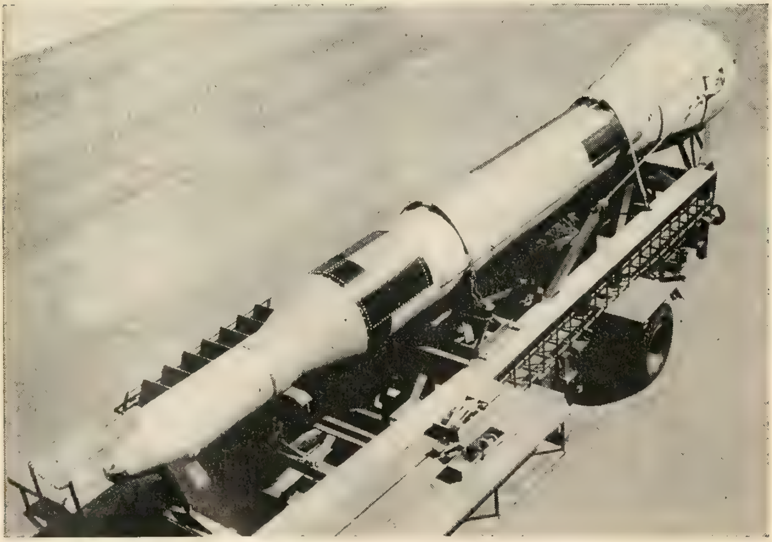
3) Satellite for measuring the magnetic field flux of the earth. The magnetometer payload was originally scheduled for SLV-4.

4) The *Vanguard* program's big effort. Satellite will have a 70-lb. payload. Total weight in orbit, including the empty final stage rocket, will be 115 lbs. Instruments include cosmic ray detectors, magnetometer, hard X-ray and photon counters.

• **"Hot"** *Vanguard*—NASA's *Vanguard* satellite number four will be boosted into orbit with a "hot" first and third stage. First stage will be the standard *Vanguard* first stage with liquid ozone added for increase of thrust. Third stage will be an improved Allegany Ballistics solid propellant. The double-base solid will have a larger nozzle and burn with a higher chamber pressure. Various components of the *Vanguard* have been slated for inclusion in other NASA and ARPA space vehicles.

• **Mars-Venus projects**—Probes to the neighboring planets, Mars and Venus, are receiving high priority with three to four attempts expected if the booster vehicles and payloads can be

Polaris Trailer Transporter



SPECIALLY-DESIGNED trailer-erector transports the *Polaris* from the assembly and checkout area to the firing pad. Hydraulically-operated jacks raise the missile clear of the wheels and establish an accurate level. Erector then takes over, elevating it to a vertical position.

made available in time. Both planets will be in a position favorable for probe intercepts during 1959.

As many as three attempts will be made to place a payload near Mars if the projects are given the go-ahead. First Mars probe would be launched during the last week of February (m/r, Nov. 24, p. 13), followed by the remaining shots in March or April.

The *Titan* ICBM reportedly has been considered for one Mars project, although its acceptance is dependent upon rate of development testing scheduled for the next few weeks. A "hot" third stage developed by JPL or Bell Aircraft will boost the payload to the cut-off velocity of 47,000 ft/sec needed to propel it out to the planet.

The first Venus probe, tentatively scheduled for early summer of 1959, will probably be assembled by JPL. Firing date will not be best for minimum thrust requirements, but due to its inferior orbit (between the earth and sun) required thrust should be about the same for the Mars probes. Most favorable launch date, calculated to reach Venus when it is in superior conjunction (opposite side of the sun and in line with earth and sun), will be in late January, 1960.

Venus payload instruments will include a magnetometer for determining rotation rate of the planet, if any; spectrograph for measuring any distortation of the spectrum lines as the result of the planet's magnetic field; microwave detector for investigation of the heavy cloud layer. A tape recorder will store all data for playback on its return to the vicinity of the earth.

• **Heat transfer problem**—Tracking and payload heat transfer are expected to be the major problems of the Venus attempt. Payload transmitter will operate on 10 watts with a projection range of 50 million miles. Heavy heat build up from the sun's radiation is anticipated during the payload's 150-day trip. Experiments to measure the hydrogen atom cloud densities in space may be included in the Venus payload. Dr. James Van Allen, designer of the *Explorer* radiation instruments, is developing the hydrogen instruments.

• *Juno* IV—An advanced *Juno* II, reported as *Juno* IV, is under development for interplanetary flights (Mars and Venus). Vehicle would use the *Jupiter* as first stage, a "hot" *Vanguard* first stage as the second stage, and a *Vanguard* third stage.

• **Lunar program**—The lunar program is expected to be expanded beyond the two Army attempts scheduled for December and February. The Christmas holiday season may force a postponement of any January firing to February. NASA reportedly has ordered several *Pioneer* and *Juno* II vehicles for the expanded program.

• *Explorer*—Currently there are no plans to continue the Army *Explorer* program, although ABMA may get the go-ahead to launch an inflatable satellite balloon of 100-ft. diameter for density studies.

• **ARPA man-in-space**—ARPA will investigate man-in-space problems by attempting to orbit and recover a chimpanzee capsule. Army *Pershing* solid propellant rocket with unspecified upper staging probably will boost a spherical epoxy plastic capsule, reinforced with piano wire, into low, short-duration orbit.

• **Baby** *Sentries*—Air Force Baby *Sentry* reconnaissance satellite program, (under new name and concept, is scheduled to get under way this month, and will attempt to launch about nine test payloads of 200-400 pounds into polar orbits. In late 1959 or early 1960 the *Atlas* C or D will be used to orbit about 12 payloads up to 4000 lbs. Air Force weather satellite will be a part of this program.

Sentry Revised: Camera to Stay on Ground

By Clarke Newlon

WASHINGTON—As m/r went to press the Department of Defense was readying a news release which would say in effect that ARPA and the Air Force have shelved the *Sentry* WS-117L reconnaissance satellite program indefinitely.

Test firings from Vandenberg AFB will be held as scheduled but the aims and intent of the entire project have been drastically—almost dramatically—switched. The project name *Sentry* will be changed. The originally-intended reconnaissance satellite now becomes a "scientific satellite." The vehicle will be instrumented, it is said, to collect all types of scientific data on cosmic rays, micrometeorites, radiation; to develop stability, to check communications—and for biomedical experiments to build toward placing man in space and getting him safely back down. Above all—at first—it will test the capability of the USAF to put a satellite in orbit.

The first firing is scheduled for the last two weeks in December. Dates have been given—December 15 and December 19. Actually, on this first try, the Air Force will be happy to get it off at any time in the planned 15-day period. It will probably be the second firing from untried Vandenberg pads. The first, a *Thor*, was scheduled to be fired early this month by a SAC crew.

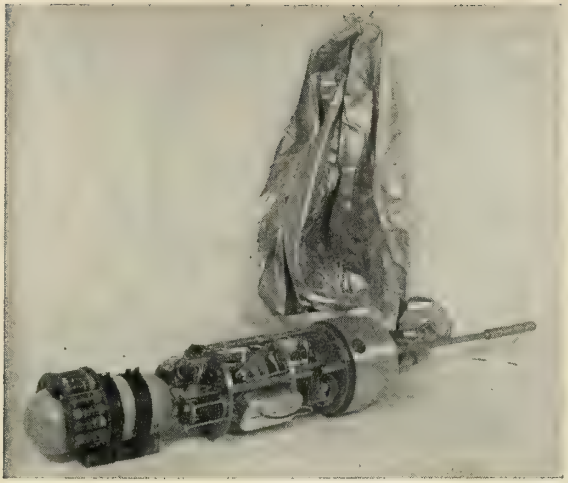
• **Reason for the change**—is largely political. The White House, extremely conscious of world opinion and our various negotiations with Russia, is understandably wary of any move which will give the Soviet government an opportunity to cry "Spy" with justification. Had the U.S. been able to launch a recon satellite under the auspices of the IGY it might have passed as a scientific achievement. To launch one otherwise would be called a purely military maneuver.

The one act which could remove the political heat would be the discovery that the Russians themselves have placed a recon satellite in orbit. The U.S. could then follow suit with the cleanest of hands. But, as many scientists have pointed out, the Russians could place such a vehicle in orbit and it could be years before we discovered that fact, if ever. It could transmit on any one of infinite frequencies, and even if spotted in the heavens (or by our intelligence), its specific identity could hardly be proven.

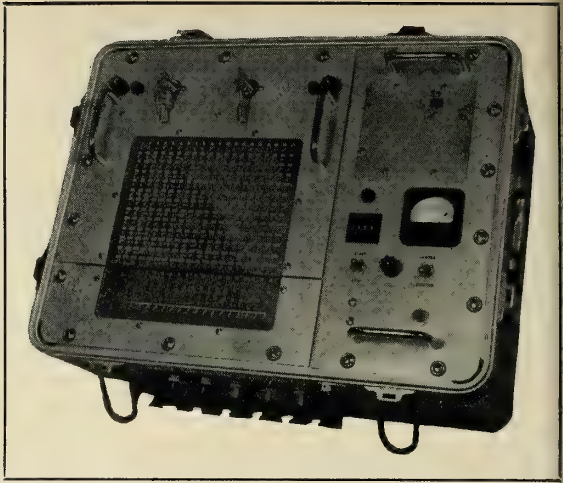
The first phase firings from Vandenberg, including the December shot, will use a *Thor* booster and a second stage, liquid-fueled vehicle developed by Lockheed, the systems manager, for the WS-117L. No "kicker" to put it in orbit is planned. The entire second stage, which will contain the payload, will be placed in orbit, if successful.

The orbiting vehicle will weigh 300-400 pounds, by far the most ambitious U.S. satellite attempt. The payload will contain little more than a battery-operated transmitter to relay the traditional "beeps." The first nine or ten firings will be with the *Thor* booster and then the project will shift into Phase 2 with the *Atlas* boosting and the payload increasing tremendously. All firings are set for Vandenberg with tracking accomplished from the same stations organized by the Atlantic range and Cape Canaveral.

There will be no camera—in the scientific satellite; under planning.



TYPICAL EXAMPLE of *Purr-Kee* payload. Tank in the foreground and balloon in rear are parts of recovery gear.



PROGRAMMER BUILT by AMF for *Purr-Kee* is capable of firing 18 rockets within 65 seconds after receiving start signal.

Purr—Kee, AMF's Versatile Sounding Rocket

by Peer Fossen

WASHINGTON—Progress with satellite rockets and ballistic missiles tends to make one forget the original member of the family—the research or sounding rocket.

But while the "big brothers" are stealing the show, scientists over the world make use of this important research tool every day. More and better rockets are being developed, and the state of the art is at a very high level.

A recent addition is American Machine and Foundry Company's *Purr-Kee,* an unguided sounding rocket developed and built by the Alexandria Division's Advanced Research Department in collaboration with the contracting agency, the Naval Ordnance Laboratory, White Oak, Md. The contract also included development and production of programmers and lightweight, portable launchers.

Purr-Kee originally was required to place a series of identical pay-loads to a large number of points in space at a given time and then return them by parachute to the ocean surface for recovery. Altitude requirements ranged from 2,000 to 18,000 feet.

• Overall configuration—*Purr-Kee* consists basically of two parts, the booster and the dart or forward body. At time of burnout, the booster is separated by drag and the dart continues on a ballistic trajectory. To meet the requirements for varying altitudes, the dart is designed for use with many engines having a wide range of thrusts.

• The booster—As mentioned, the original altitude requirements were in the 2,000 to 18,000 feet range. For these heights, AMF engineers powered the dart with either *Deacon, HPAG, Falcon,* or 5-inch *HVAR* engines. The trajectories and altitudes attained with each of these rockets at various launching angles are plotted in Figure 1.

Much higher altitudes are attainable by using other boosters such as multiple *Deacons*—double or triple—or the *DAN,* which is a two-stage *Deacon-Nike* combination. Some of the possible dart-booster combinations are shown in Figure 3.

Only slight modifications are required on the various boosters before they can be used to push the *Purr-Kee* dart to a greater altitude:

1) Addition of fins (if motor is not so equipped).

2) Mounting of launching shoes.

3) Adaption of motor front end to the motor-dart coupling.

Adding to the flexibility in use of boosters is the ability to use a large variety of parachutes which can withstand a long range of velocities and altitudes.

• The dart—The *Purr-Kee* dart, which measures six inches in diameter and six feet in length, contains a nose cone, the instrumentation payload, parachutes, and recovery gear.

At a preset time during the ballistic flight, the parachutes are deployed and the dart descends slowly back to earth. The shock encountered at parachute deployment also separates the nose cone to expose the instrumentation section.

The mechanical timer which initiates a squib to release the parachute can also be made to initiate actions in the instrumentation and recovery systems. In past use, this timer has been started by launch accelerations or by an electrical signal firing an explosive motor. The timer can also be lanyard-started if desired.

Purr-Kee's water recovery system consists of a balloon which is inflated after water contact, and a small radio transmitter with antenna to lead the recovery team to the payload. The purpose of the balloon is to add to the buoyancy and visibility of the dart itself.

Careful attention has been given to reduction of the drag of the dart to achieve maximum range. On the other hand, less emphasis was placed on this factor in the booster section where drag forces actually improve the separation action.

The present dart design leaves a cylindrical volume of approximately 143 cubic inches for payload. If recovery gear is stripped, an additional 130 cubic inches could be utilized for instrumentation.

Purr-Kee's ability to accurately place a payload at a given point in space at a given time is due in large measure to an accurate determination of the drag co-efficient and other aerodynamic characteristics, measured by extensive flight tests during development of the rocket. In addition to the booster flexibility, the weighted nose cone provides for two very important advantages:

1) Means by which overall rocket weight can be adjusted to secure a fine adjustment on range. (A sample curve of this for the HPAG booster is shown in Figure 2.)

2) Excellent stability characteristics to entire rocket before separation—since weight is in an extreme forward position.

- **The launcher**—The lightweight launcher developed for *Purr-Kee* can be quickly and easily erected and operated by a two-man crew. Launching angle is adjusted by a turnbuckle at the rear of the unit. This launcher has performed very satisfactorily under the most difficult field conditions.

Purr-Kee **ROCKET being readied (on old launcher) for launching at Wallops Island.**

- **The programmer**—The programmer was designed and built to fire salvos of *Purr-Kee* rockets and planned for use with a radio controlled relay on an unmanned station. Each programmer was made as a battery-powered unit capable of firing 18 rockets within 65 seconds after receiving a start signal.

The start signal can be given by a switch or relay. Accurately spaced pulses are produced each quarter second by a switch and are cam assembly driven by a chronometrically governed motor. The pulses are sent to a 260 point patch panel through a set of stepping switches, which advance one position after each pulse. The stepping switches cycle to provide the 260 pulses and reset to start position. The timing cam is set manually to the start position.

Patch cables with spring loaded vibration and pull-proof plugs are used to connect the desired pulses to the output panel. Three leads from each output connector are brought up to the output panel. Two key operated arming switches normally keep power off the patch panel. The timing system is not affected by the safety devices and can be tested without providing output pulses.

The output pulses have a time accuracy of ± 15 milliseconds of the preset time after the first two seconds. The accuracy during the first two seconds is less. Each pulse is 24 volts with a maximum current of 30 amperes.

Programmer Specifications:

Start Signal
momentary switch closure
Timing range

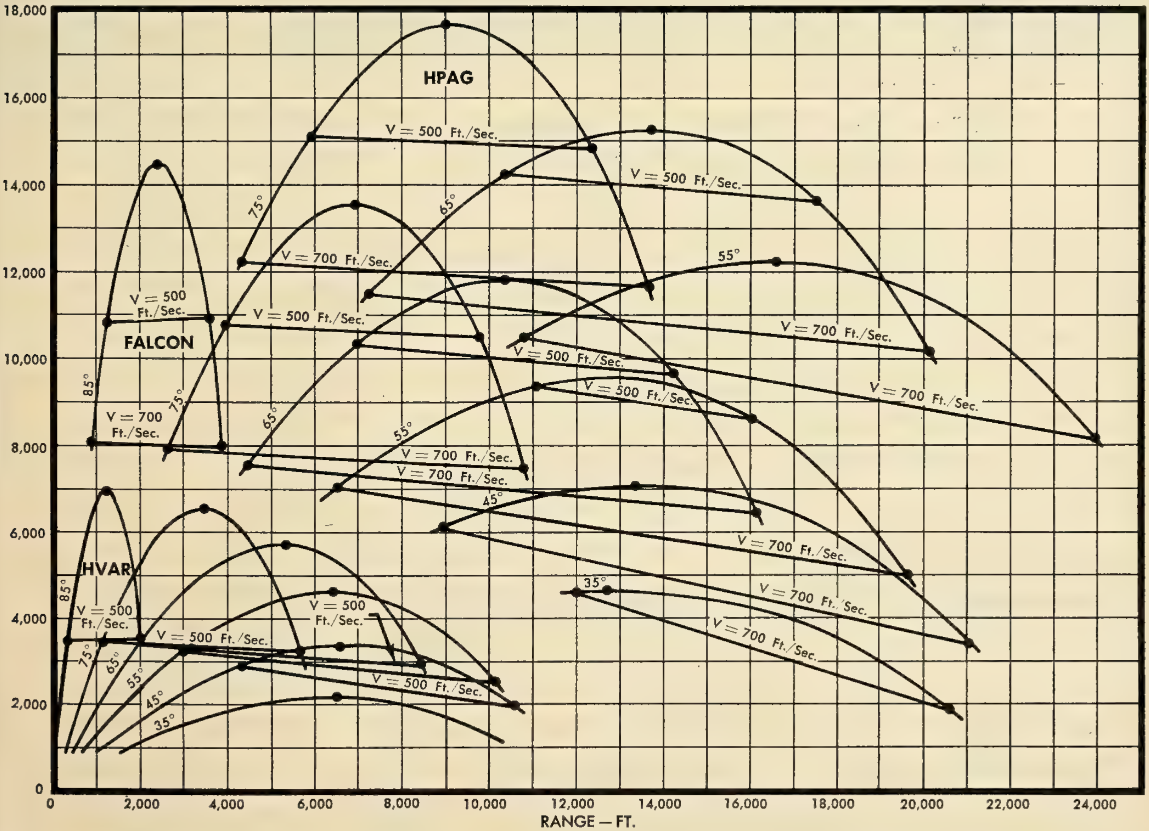
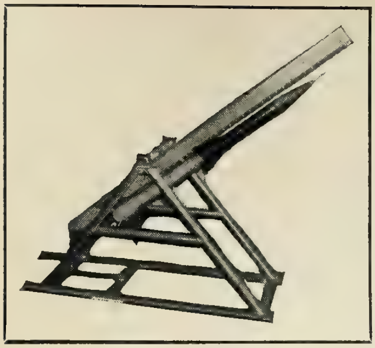


Fig. 1. Trajectories and altitudes attained with ***Purr-Kee*** **dart at various launching angles, using different boosters.**



Purr-Kee **in firing position on new lightweight, portable launcher. Launching angle is adjusted by turnbuckle at rear.**

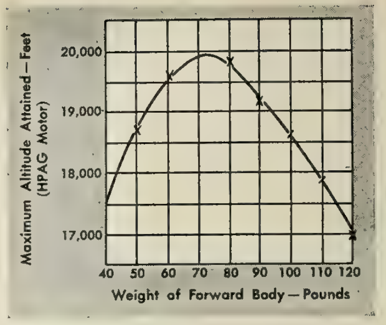
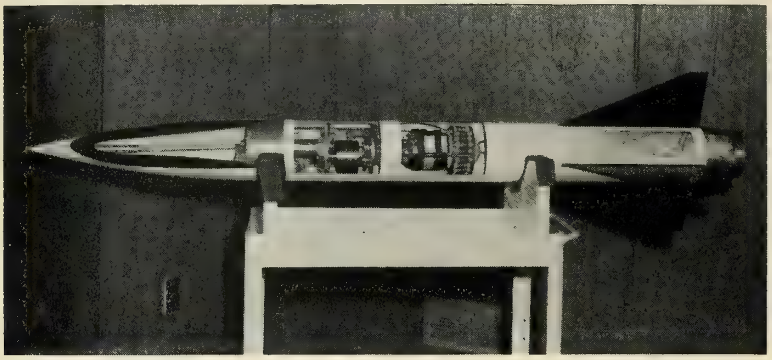


Fig. 2. EXAMPLE OF how weight of nose cone, in addition to booster flexibility, can be changed to secure adjustment.



CUT-AWAY MODEL of *Purr-Kee* **dart showing payload and recovery gear.**

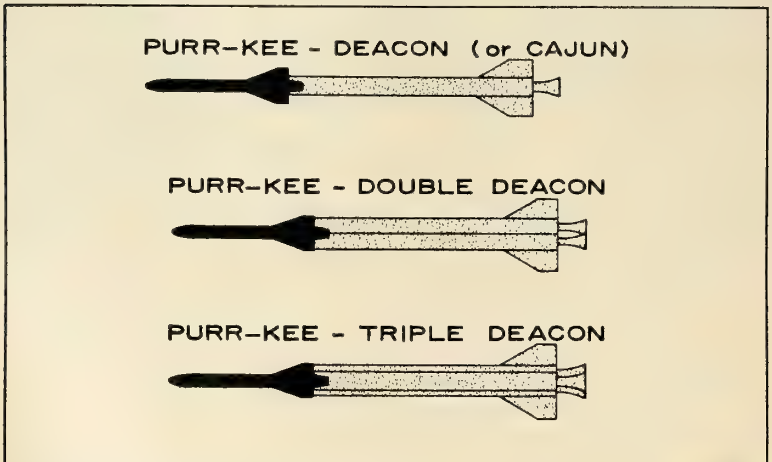


Fig. 3. Examples of possible *Purr-Kee* **dart/booster combinations.**

64¾ seconds
Resolution
¼ second
Accuracy
± 15 milliseconds after 2 seconds
Pulse length
200 milliseconds
Pulse height
24 volt
Pulse current
30 amp max
Power supply
24 volt 4 A.H. nickel cadmium battery
Dimensions
19¾" x 14¾" x 13"
Weight
40 lbs.
Environmental
waterproof when closed

The housing is a fiberglass transit case with all connections made through waterproof connectors. The transit case becomes a waterproof asesmbly when the top is clamped down.

Industrial Output

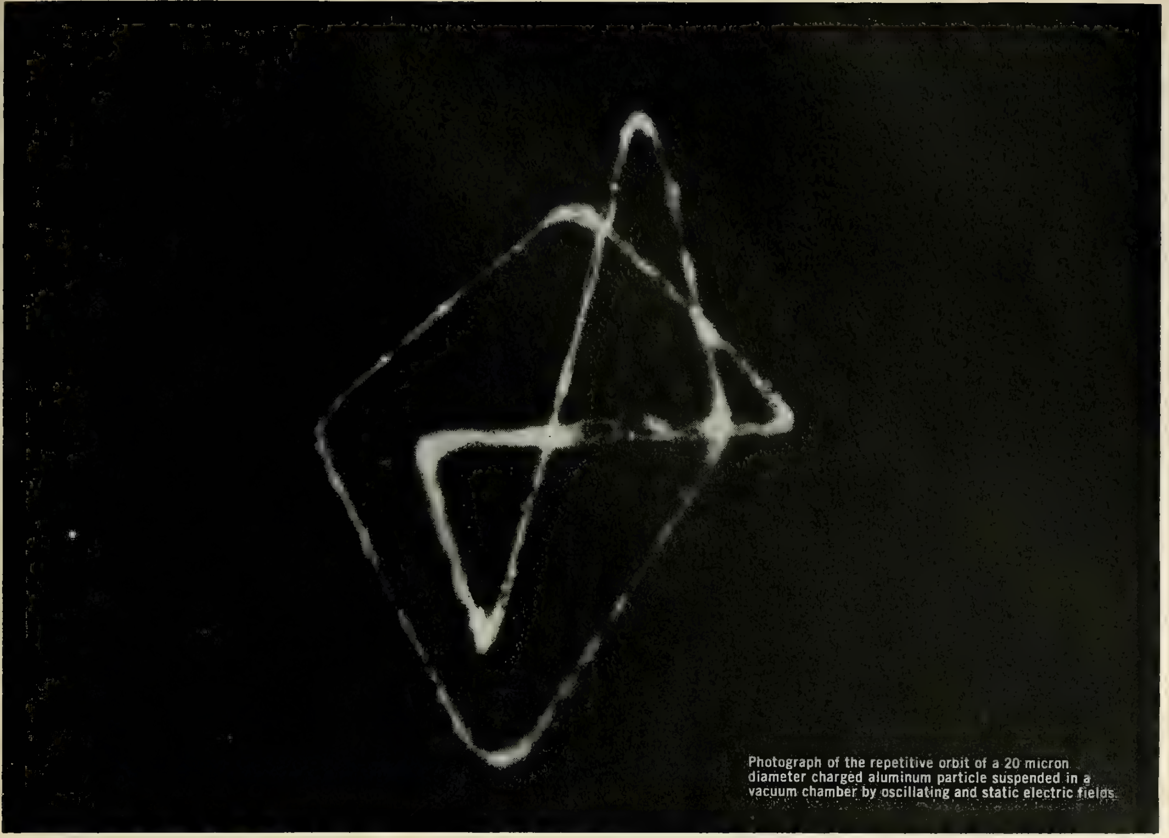
Soviets Claim 10% Rise Over 1957 Period

New data on the productivity of Soviet industry has been published, indicating an increase of 10% over the same nine months of 1957. The Central Statistical Board of the USSR has reported that the state plan for the third quarter of 1958 has been fulfilled by 102%.

According to the figures, the first nine months of this year show an output in the iron-and-steel and nonferrous metals industries 9% higher than last year. The corresponding figures for the chemical and rubber industries show a jump of 12%, and those of the machine-building industry (basis of technical progress in the Soviet economy) indicate a hike of 14%.

In absolute volume, steel smelting increased by 8% and amounted to 40.8 million tons, indicating a total annual output of 55 million tons. The Central Statistical Board's report points out that in this nine month period, pig-iron and steel production in the USSR more than doubled that of 1948.

Labor productivity has also increased, according to the report. The same nine-month period shows that labor productivity has increased 5.6%, and the Board notes that over the last forty years, Soviet industrial workers have increased productivity on an average of 6 to 8% annually, while the U.S. figures show the same parameter as having increased only on an average of 1.5 to 2% annually.



Photograph of the repetitive orbit of a 20 micron diameter charged aluminum particle suspended in a vacuum chamber by oscillating and static electric fields.

ELECTRODYNAMIC ORBITS

By the application of properly chosen alternating and static electric fields, electrically charged particles can be maintained in dynamic equilibrium in a vacuum against interparticle and gravitational forces. This is illustrated in the above photograph of the orbit of a charged dust particle. During the time of exposure the particle traversed the closed orbit several times, yet it retraced its complicated path so accurately that its various passages can barely be distinguished.

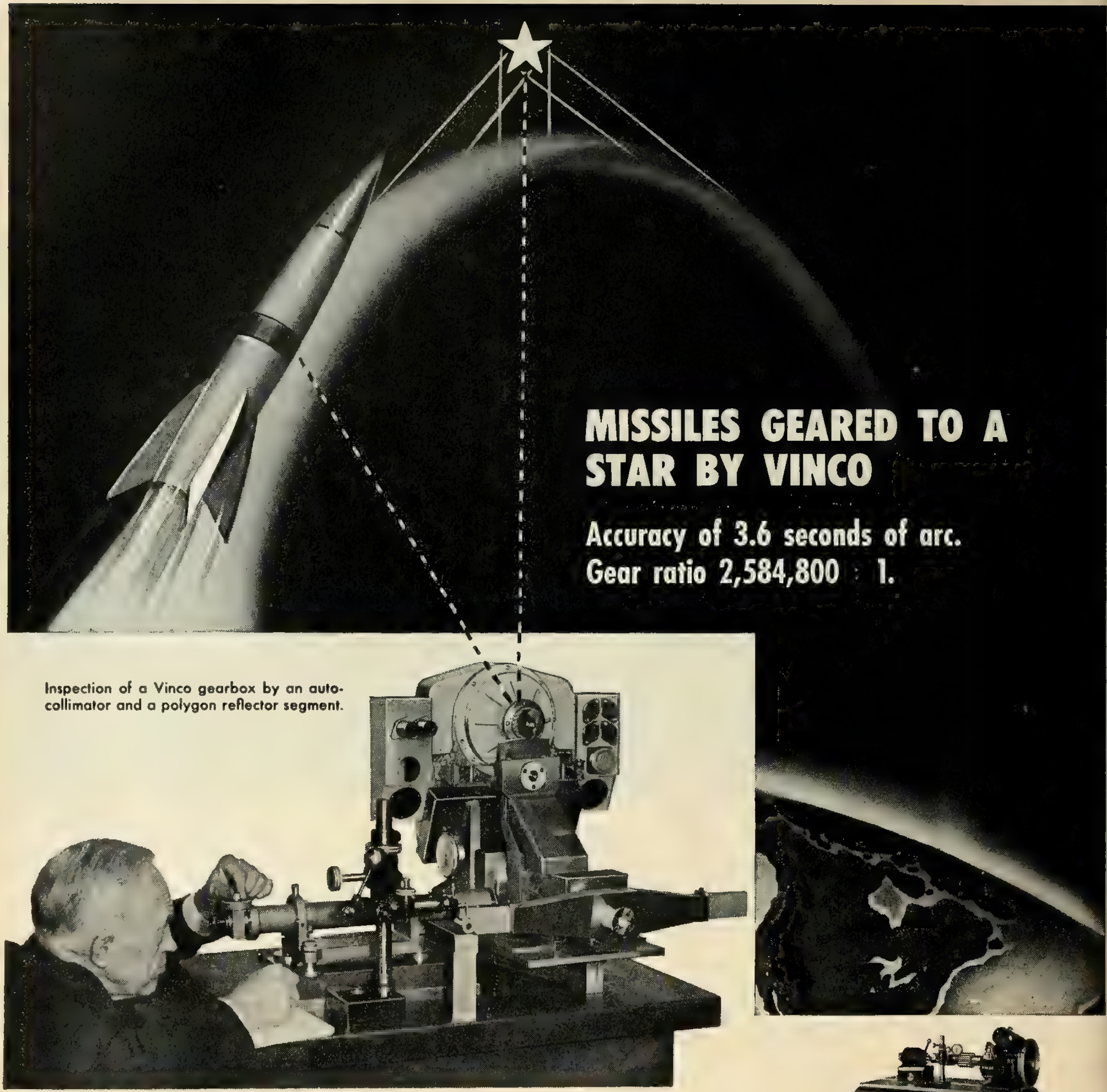
The range of particles of different charge-to-mass ratios which can be contained in this manner is determined by the gradients of the static and alternating electric field intensities and by the frequencies of the latter. In the absence of static fields and for a given electric field strength, the minimum frequency required for stable containment of the particles is proportional to the square root of their charge-to-mass ratios. Thus, charged colloidal particles require the use of audio frequencies, atomic ions need HF frequencies, while electrons require the use of VHF and higher frequencies.

Under the confining influence of the external fields, the particles are forced to vibrate with a lower frequency of motion which is determined by the external field intensities, space charge, and the driving frequencies. If the initial thermal energy is removed, a number of particles may be suspended in space in the form of a crystalline array which reflects the symmetry properties of the external electrodes. These "space crystals" can be repeatedly "melted" and re-formed by increasing and decreasing the effective electrical binding force. These techniques offer a new approach in the study of plasma problems and mass spectroscopy in what may be properly termed "Electrohydrodynamics."

At The Ramo-Wooldridge Corporation, work is in progress in this and other new and interesting fields. Scientists and engineers are invited to explore current openings in Electronic Reconnaissance and Countermeasures; Microwave Techniques; Infrared; Analog and Digital Computers; Air Navigation and Traffic Control; Antisubmarine Warfare; Electronic Language Translation; Radio and Wireline Communication, and Basic Electronic Research.

The Ramo-Wooldridge Corporation

LOS ANGELES 45, CALIFORNIA



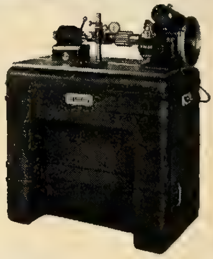
MISSILES GEARED TO A STAR BY VINCO

Accuracy of 3.6 seconds of arc. Gear ratio 2,584,800 : 1.

Inspection of a Vinco gearbox by an autocollimator and a polygon reflector segment.

Test stands for missile guidance systems include a gearbox built by Vinco to isolate the gyro system from the earth's rotation. Driven by an 1800 RPM synchronous motor, with a gear head stepdown to 1RPM, it produces an output motion of one turn in one sidereal day. Output accuracy limit of 3.6 seconds of arc reflects the action of 8 Vinco gears and 9 precision ball bearings. It is equivalent to .00018″ error of motion at the pitch line of a 32 diametral pitch, 20° pressure angle, 20.625 pitch diameter output sector.

Such accuracy is a must for checking the error or drift of gyroscopic and inertial guidance equipment. The gears in the sidereal rate test gearbox were ground and inspected on Vinco equipment by Vinco craftsmen. This personnel and equipment are available for producing gears of the same high precision for you.



The Vinco Optical Master Inspection Dividing Head is the most accurate instrument of its kind for checking angular spacing. Accuracy is guaranteed within a total variation of 2 seconds of arc (± 1 second). This instrument is available in both standard and heavy duty models.

VINCO CORP., 9111 Schaefer Hwy., Detroit 28, Mich.

Huntsville: From 'Cotton' to 'Space'

President's decision on transfer of Army missile talent to NASA administration is awaited with concern and even anxiety.

by A Special m/r Correspondent

HUNTSVILLE, ALA.—The President's verdict on Dr. Keith T. Glennan's proposal to transfer 2,100 scientists and engineers from the Army Ballistic Missile Agency to his National Aeronautics and Space Administration is being awaited with concern and even anxiety here in this missile-conscious city.

Ten years ago, Huntsville called itself the cotton capital of Alabama. Today, hugh highway billboards proclaim it the "Space Capital of the Universe." And many of the 65,000 to 70,000 residents know they will be vitally affected by the President's decision, one way or another.

The missile and space industry is a big one in Huntsville, for it directly provides close to 25,000 jobs and an annual payroll approximating $125 million and is the headquarters of the Army Ordnance Missile Command, which spends $2-billion annually.

Keystone of the industry is the sprawling 35,000-acre Redstone Arsenal, which on the day Glennan's proposal was first forecast by m/r, employed 19,972 including 12,283 civil service workers, 3,790 military personnel and 3,899 contractor employees.

In addition, off the Redstone reservation scattered throughout the city are a score or more satellite industries, directly dependent on the missile and space effort of the Army. Add to those the thousands of service firms—motels, airlines, restaurants and the like—whose business caters to the personnel assigned to or visiting at Redstone Arsenal.

It becomes clear why any shift in the missile business is of paramount interest locally.

The Glennan proposal would directly affect only 2,100 persons, but this group is less than half of the ABMA total of 6,758 personnel, of which 5,012 are Civil Service, 358 are military and 1,388 are contractor employees physically located on the arsenal.

• **Big question**—The big question is, if the President approves the Glennan proposal, what will happen to the remaining members of the team? Army scientists including Wernher von Braun, Ernst Stuhlinger and others insist the chiefs of the team (the ABMA group) cannot function without the Indians, and the Indians cannot function without the chiefs.

Hopes are high, of course, that the NASA transfer—which would be administrative only—will not be approved, and the President will, instead, allow a continuation of the present policy of NASA, ARPA and other functions to assign projects to existing commands and installations, rather than changing bosses.

If this is done, high Army officials

THIS FORMER textile mill with some 850,000 square feet of floor space is now the Huntsville Industrial Center. About eight miles from the Redstone Arsenal reservation, it provides accommodations for Warrior Tool and Engineering Co. (Diversey), Spaco Mfg. Co., Chrysler and Brown Engineering Co.

BROWN ENGINEERING Co. employees, J. B. Middleton and Hans Weickardt check analysis of a proposed missile system.

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producing **INTEGRATED AIRCRAFT ANTENNA SYSTEMS**..from concept to roll-out

Designing and producing high performance aircraft antenna systems calls for highly developed skills and advanced techniques. But the key to their successful operation is integration of the antenna into the airframe. At Temco, proven airframe and antenna engineering capabilities unite to produce optimum performance integrated airframe-antenna systems.

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With its Antenna Research Laboratory and new precision Test Range, Temco is keeping a step ahead of today's high-performance aircraft and missiles. New antenna-airframe designs are under development for operation from 30 MC to beyond 30,000 MC. Integrated antenna systems . . designed and produced by Temco for aero-space craft electronics . . are indicative of Temco's system of weapons management. In subcontracts . . or complete systems, Temco's capabilities are ready to meet your challenge.

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say, the Army will retain its missile capability and the effectiveness of the successful ABMA development team. If it is not, serious delay to both NASA projects and the Army missile program may be the result. In addition, if physical facilities, such as laboratories and equipment are transferred, it will necessitate an expensive rebuilding program to duplicate them.

• **Far-reaching decision**—There is also local concern over the effect of the NASA proposal on the off-arsenal satellite industries. One likely to be affected is the **Chrysler Corp.** which employs more than 1,000 persons in its Huntsville plant. Activities are confined to "engineering services" rather than production, and the firm is primarily engaged in the *Jupiter* and *Redstone* programs.

There are a number of other satellites which might be affected: **Brown Engineering Co., Diversey Consultants & Designers, Inc., Southern Associated Engineers, Redstone Machine & Tool Co.** and others. All do work for ABMA, but they also do work for other agencies at Redstone, too, and the degree to which they would be affected is uncertain.

The picture is not completely dark for Huntsville. Glennan's proposal would not mean the physical transfer of the ABMA group, although it might mean the ultimate death of the Army's longer range missile program.

But there is considerably more to the picture here than ABMA.

In addition to ABMA, Redstone is also the site of the Army Rocket and Guided Missile Agency, which controls more money actually than does ABMA. It employs 5,262 people, including 2,921 civil service, 2,018 contractor personnel, and 323 military.

ARGMA, of course, has the anti-missile missile *Nike-Zeus* program, as well as R&D cognizance over all the Army's shorter range missiles. In addition, its Field Service Division and Industrial Procurement Division virtually control the Army missile program all over the world, from research and development, contracts to developers and manufacturers production, logistics, storage, and distribution.

• **But future bright**—As each new missile system is added to the Army array, work is increased for ARGMA. Regardless of the route of the long range missiles, such as *Jupiter,* the future remains bright here.

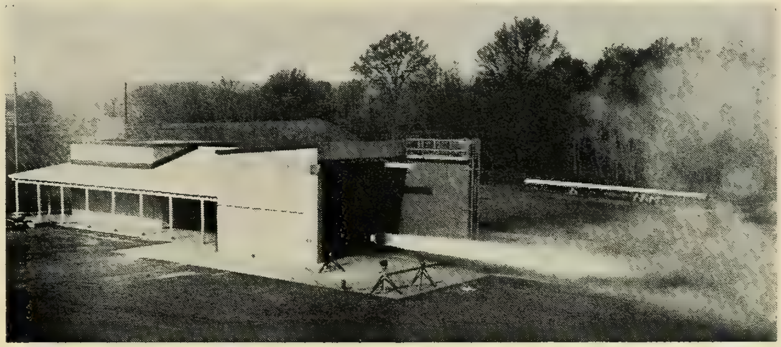
The same is true for the Ordnance Guided missile School, which employs 3,024, including 2,253 military, 508 Civil Service and 263 contractor personnel.

In addition to training servicemen from all of the U.S. services, OGMS is training a growing number of North Atlantic Treaty Organization personnel from France, Denmark, Italy, the Netherlands, West Germany, Turkey, Greece, Norway, Great Britain and Canada.

Redstone Arsenal itself in housekeeping activities for the three agencies, employs 4,426 persons.

So, actually, there are 13,214 jobs at Redstone that are not likely to be affected very much—by the NASA proposal.

And off the arsenal, the satellite engineering and development firms actually are more geared to prototype business than to production in quantity and they might fare not too badly under NASA, especially if the civilian agency's budget is increased, and added to whatever budget remaining in ABMA.



THIOKOL CHEMICAL CORP. is one of Huntsville's larger missile companies. Here in this static test facility, work is carried out on many systems.

• **Ten years old**—The missile industry has come a long way in Huntsville since it was first born in the waning months of 1949, less than ten years ago.

It was then that Huntsville civic leaders were up in arms over losing the Air Force research and development center to Tullahoma, Tenn. Some obscure colonel named Toftoy (now Maj. Gen. H. N. Toftoy) in Army Ordnance had put a "hold" on the idle Redstone Arsenal properties, and the Air Force, with the urging of Senator McKellar of Tennessee moved on to Tullahoma.

People in Huntsville were not at all pleased over the prospect of "a bunch of foreigners" moving in to develop missiles. What were missiles, and would these Buck Rogers ideas amount to anything? they asked.

The people sing a different tune today, of course, for the missile industry is the backbone of Huntsville's economy.

With a meager beginning in temporary buildings, the arsenal has steadily grown through the years to tremendous proportions, and it is still growing.

Today, excluding capital equipment investment, the replacement value of Army property and buildings is conservatively estimated at $191.5-million.

In fiscal 1958, the Army completed construction projects costing $21.6-million. Another $12-million of construction is in progress, and additional construction involving $20-million is scheduled to be started before January 1.

Facilities range from the towering 145-foot tall steel and concrete static test stand which is one of the largest in America to a maze of complex and expensive laboratories which contain electronic brains and other costly equipment necessary for the continuation of a centralized missile development organization. In addition to the vertical test stand, which has been used for the *Jupiter* program, there is a 1-million-lb. thrust capacity horizontal test stand for solid propellant engines, such as the 500,000 lb. *Nike-Zeus* booster.

• **Employment jumps**—Employment, which crept slowly upward after the missile center was established in 1950, was slightly below 9,000 at the end of 1955, just before ABMA was established here. Almost three years later, that figure is more than doubled.

A part of the arsenal's growth is a result of the tremendous expansion of **Thiokol Chemical Corp.**'s Redstone Division, one of two major contractors housed on the arsenal.

A national leader in solid-propellant development, Thiokol today employs here approximately 1,650 persons, and its Redstone Division sales to all armed forces, to ARPA and NASA this year are reported to be well in excess of $60-million.

Thiokol projects include R&D work on *Pershing, Bomarc* booster, *Hercules* booster and sustainer, *Nike-Zeus* booster, *Minuteman* sustainer, *Falcon, Sergeant, Hawk, Lacrosse, Recruit* and others. The company also developed here the USAF *X-17* rocket motor which has become an "off-the-shelf" item used in numerous projects. Another Redstone Division product were the *Polaris* "test vehicles" which were used in the *Polaris* program until the last two firings.

When Thiokol first opened in 1949, it employed 35 people in three buildings. Today, 35 buildings on 600 acres are jammed with the 1,650 present employes, and an extensive building program is reported in the making.

- **Satellite industries**—An example of satellite industry growth is **Brown Engineering Co.** which opened here in 1953 with a nucleus of only 10 people in an uptown office building.

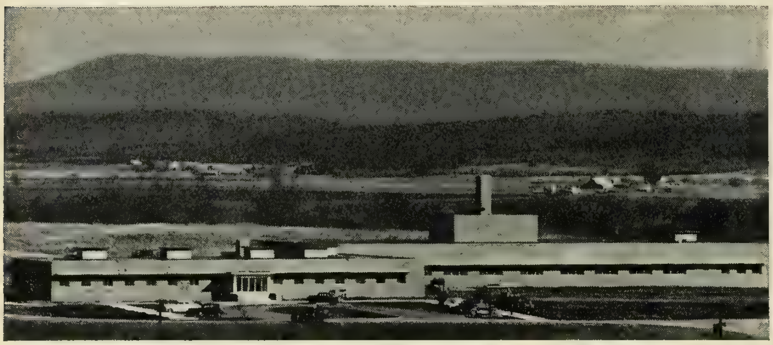
Today, there are nearly 600 Brown employes working in one of the most diversified programs in the missile industry, occupying 80,000 sq. feet of floor space with 50,000 more available for expansion.

Brown's activities range from basic R&D in any phase of missile hardware, including an extensive machine shop operation, to the manufacture of printed circuits.

Specific examples of its work include feasibility studies for *Project Orbiter*, frame R&D for *Jupiter* (nose cone designs and aft section designs); guidance and control research, development and frabrication (air bearings, accelerometers, gyros, servo motors, micropositioners); propulsion R&D (turbine exhaust nozzle control mechanisms, gimbaling blow-off nozzle for directional control and thrust termination for solid propellant motors), testing and calibration; ground support equipment R&D and fabrication, including missile trailers, instrumentation trailers, flame deflectors, personnel hoists and the like.

On December 15, 1957, the company had 157 employes. Today there are 544. Net sales in 1956 totalled $770,386, while in the first eight months of 1958 net sales reached $2,409,457.

Brown, along with **Chrysler, Diversey** and **Spaco Manufacturing Co.,** all engaged in missile work, have taken up residence in a former textile mill now called the Huntsville Industrial Center.


HEADQUARTERS FOR Rohm & Hass Chemical Co. at Redstone arsenal

The mill closed in 1957, and was purchased by local citizens. Its interconnected 850,000 sq. feet of floor space are being leased to government contractors who wish to avoid the expense of building erection.

The huge reinforced concrete structure has proven ideal for the missile industry, since it is capable of taking great weights on all its floors, and is easily air conditioned.

The only major missile contractor beside **Thiokol** which is located on the Arsenal proper is the **Rohm & Haas Chemical Co.,** which does applied research in both solid and propellant fields, although the emphasis is on solids.

Employing 250 persons, the company's sales this year are reported to total between $2,000,000 and $2,500,000.

General Electric, which operates the computations laboratory has a considerable force here, as does the **Rocketdyne Division of North American Aviation Co.** Both of these number in excess of 100 employes, but accurate figures are not available.

Other contractors are scattered throughout the city. These include **Southern Associate Engineers and Consultants and Designers, Inc.,** so far as the larger ones are concerned.

Chrysler has the bulk of its personnel in the Huntsville Industrial Center, but it also has locations in the city and on the Arsenal.

- **Off-shoot gains**—Aside from contractors, the missile business still has considerable influence on the city's economy, particularly in hotels and motels, and the airlines.

Although some 500 motel and hotel rooms have been added within the last two or three years, rooms are still at a premium Monday through Thursday, and even Fridays and Sundays are crowded as contractors' representatives pour into the city to conduct their business at Redstone Arsenal.

Scores of missile firms have resident representatives here, although most of them shy from publicity, and a complete list is almost impossible to obtain.

Many of the firms maintain offices in the motels and hotels.

Another business which has profited tremendously from the missile business is the airline activity here. Capital and Eastern offer 11 daily flights, including two non-stop to Washington and New York. Southern Airways has added two additional flights and on January 1 will add two more for a total of 16 scheduled flights, nearly all of which "load up" coming in to or leaving from Huntsville. The **Chrysler Corp.** maintains its own shuttle service between Detroit and Huntsville, flying a special charter DC3 five days a week. **Martin Company** also uses its company plane.

In addition to all of this, is the growth in community facilities necessary to any rapidly expanding community. More than 2,500 houses will be built in the city this year alone.

Huntsville's population in 1950 was officially 16,472, and counting the immediate area around it, the population was about 30,000.

Today, it is in excess of 65,000, and is believed to be about 70,000, but no accurate figures are available.

Schools, churches, stores and other community falicities have grown proportionately, and have kept pace for the most part.

While Huntsville has other industrial activity, there is no question that missiles are the "big factor" in the area's economy.

That's why the NASA action is under such keen scrutiny here.

...NEWS IS HAPPENING AT NORTHROP

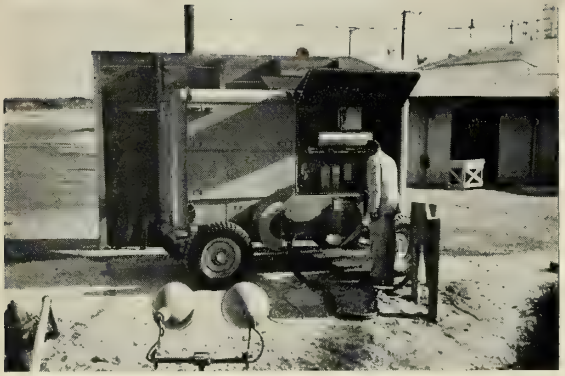
NORTHROP T-38 TO TRAIN THE NEW GENERATION OF SPACE AGE AIRMEN!

Ahead of schedule! Northrop introduces the first lightweight, low-cost trainer with combat performance characteristics, in which U.S. airmen of the space age can safely master the very special art of supersonic flight.

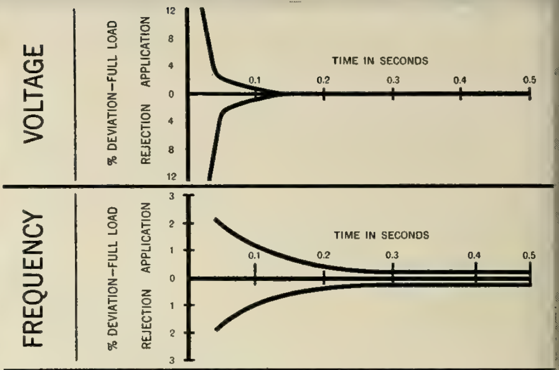
The twin-jet T-38 pioneers a new Northrop family of low-cost, high-performance aircraft. Another member, Northrop's N-156F NATO-SEATO counterair fighter, is now being built at Hawthorne, California. Final mockup of the N-156F is shown in background of above illustration.

Both aircraft are evidence of Northrop Division's skill in creating and producing higher quality products at lower cost. With other current projects, the T-38 and N-156F illustrate a new kind of cost-conscious creativity—are results of Northrop's budget-minded management team, the unique Performance and Cost Evaluation Program called PACE, and of Northrop-developed production techniques.

NORTHROP
HAWTHORNE, CALIFORNIA
A Division of Northrop Aircraft, Inc.



Snark Missile is powered by this Caterpillar Electric Set, photographed at Cape Canaveral, Florida. Full designation: Caterpillar 60 KW 400-cycle 120-208 Voltage Low Silhouette Portable Ground Support Unit with Precision Control Regulation.



Almost instantaneous return to normal of the new low silhouette Cat power unit (left) under conditions of full-load application and rejection is shown in the above graphs. In each case test was made under a voltage output of 117.4 volts.

Caterpillar Engines help powe

Rocket boosters blazing a flaming trail, the Northrop Snark SM-62, first U. S. intercontinental guided missile, roars skyward from Cape Canaveral, levels out and hurtles south to the Caribbean.

The precise power used for ground support of the Snark is provided by a Cat Electric Set, designed and engineered for the missile program.

On isolated, down-range islands, the missile is picked up on radar, monitored as it streaks by, and the in-flight data is recorded and transmitted to Cape Canaveral for processing.

The power for these tracking stations—for the delicate, complex equipment and for living facilities for station personnel—is provided by Caterpillar Stationary Electric Sets.

Modern, heavy-duty diesel engines by Caterpillar are playing an important role in the rocket and missile program, and in other important military applications.

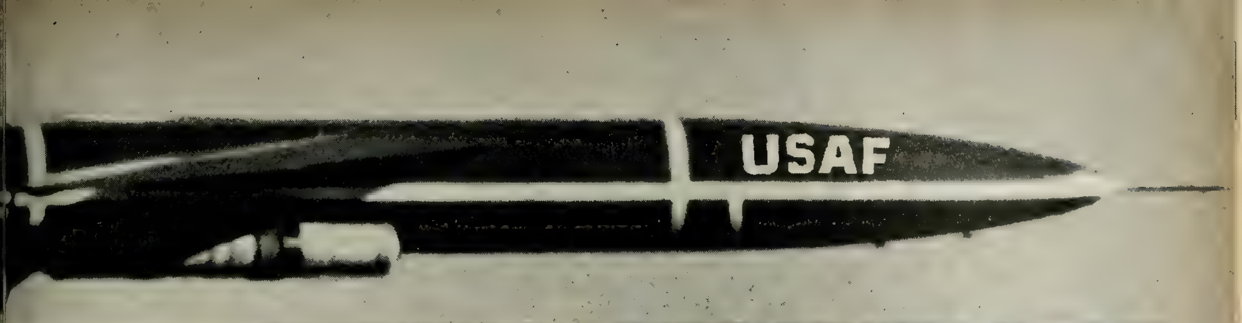
Caterpillar Engines can operate in any climate or altitude. Cat Engines were chosen to supply power for the Antarctic Expedition for the Geophysical Year (Operation Deep Freeze).

Caterpillar Engines can operate on any fuel, from JP-4 through No. 2 furnace oil, without adjustment or dilution. This means Cat Engines can use readily available fuels, eliminating storage or safety problems.

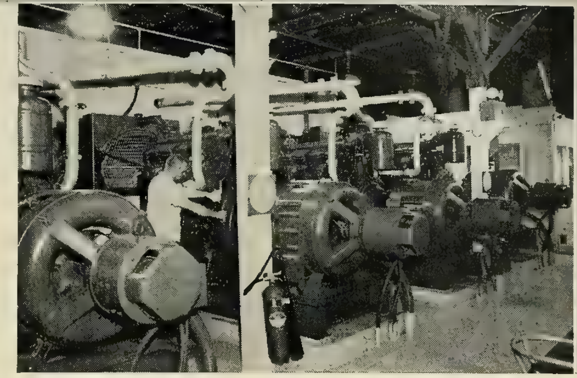
Relatively untrained personnel can operate and maintain these dependable power packages. Only

An electric organ helps relieve the monotony of life on these vital but lonely stations. Caterpillar Engines supply the electric power needed to operate effectively in remote places.

Weather information needed for missile testing is gathered in this weather station on Eleuthera. Precision equipment used here demands steady, constant diesel-produced electricity.



Central Control at Grand Bahamas Auxiliary Air Force Base is powered by Cat Electric Sets. This is one of 12 such stations that chain southeastward from the Florida Coast to Ascension Island, south of the Equator between Brazil and Africa.



These are Caterpillar Engines supplying electric power on Eleuthera Auxiliary Air Force Base, one of the down-range tracking stations. Each of the engines, generating as much as 68,000 KWH each month, has been operated more than 90,000 hrs.

United States missile program

two minor adjustments are necessary on a Cat Engine: fan belts and valve clearance.

An important factor in military preference for engines by Caterpillar is the world-wide availability of Caterpillar parts and service—832 facilities in the Free World; 398 of them within the Continental United States.

Modern, heavy-duty Caterpillar Engines are a result of more than a quarter century of diesel leadership. Creative engineering plus a quality of workmanship that is the standard of the industry has made Caterpillar power an overwhelming choice where precise, dependable diesel engines are a must.

Engine Division, Caterpillar Tractor Co., Peoria, Ill., U.S.A.

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

ENGINE POWER BY CATERPILLAR

N. W. Ayer & Son, Inc.

"We've had little down time with our dependable Cat Engines," says Burt Niro, Pan American Airways Base maintenance supervisor, Eleuthera. James McCullough, base manager, is at right.

Special Governmental Projects, Dept. MI12, Engine Division
CATERPILLAR TRACTOR CO., Peoria, Ill.

☐ Please send me additional detailed information on Ground Support Electric Sets.

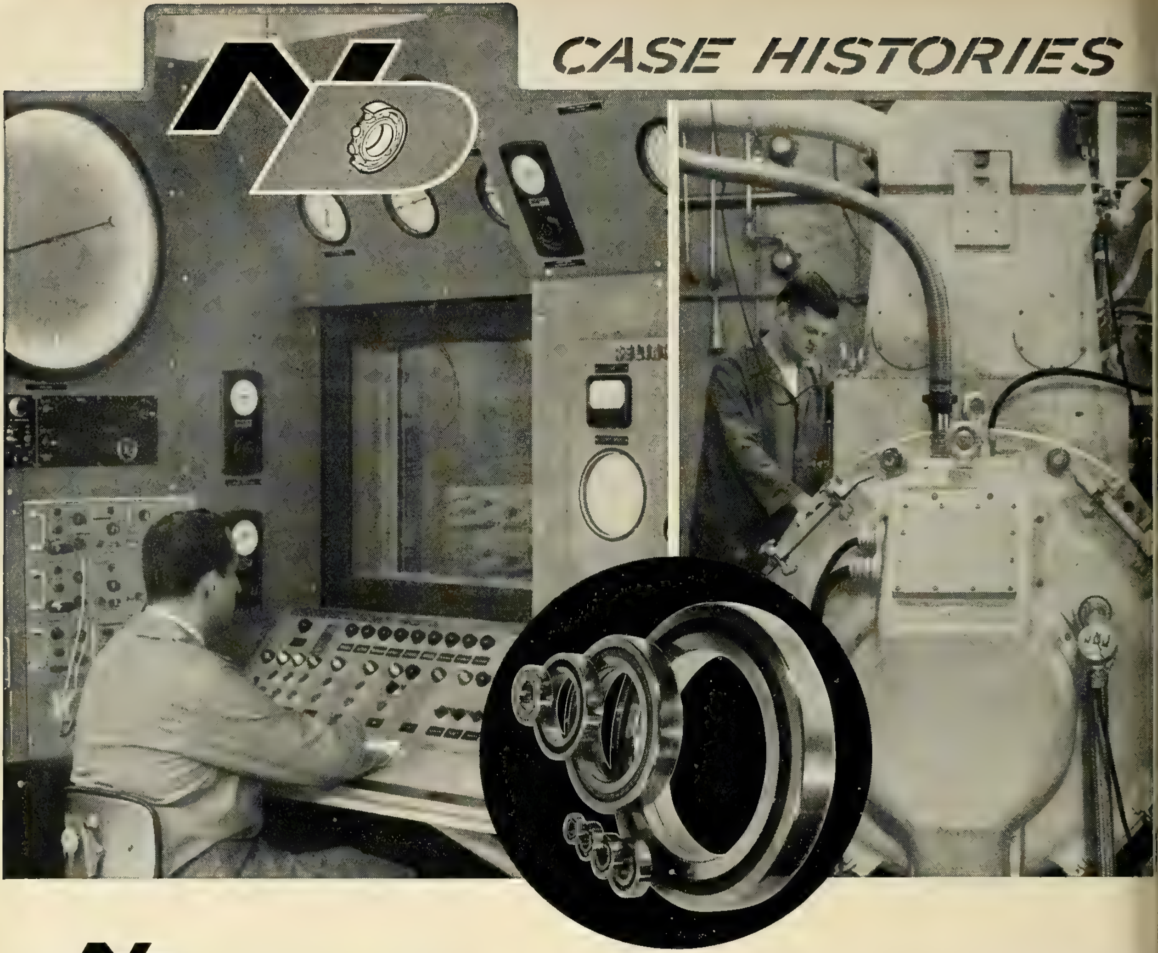
*Name*________________________________

*Base (or Firm)*__________________________

*Address*______________________________

*City*__________________*Zone*_____*State*_______

CASE HISTORIES



Research Labs Keep Pace With Giant Stride Of America's Air Industry!

CUSTOMER PROBLEM:

Require test rig for measuring full scale aircraft turbine bearings. Test rig must simulate actual operating conditions.

SOLUTION:

N/D engineering, in cooperation with customer under the direction of a defense agency, developed the aircraft turbine bearing testing equipment shown above. The Test Rig Control Console, shown on the left, initiates and controls tests, and completely records *all* operating performance characteristics. The test stand itself, above right, simulates the actual conditions to which the bearings are subjected in flight. It develops radial loads of up to 25,000 lbs. . . . and thrust loads reaching a maximum 75,000 lbs. Bearings up to 110mm bore are tested at speeds as high as 20,000 r.p.m., in temperatures ranging up to 1200° F. Research facilities such as this are your assurance that New Departure stands ready to work closely with you on *your* bearing research problems. For information on New Departure precision Aircraft and Instrument ball bearings, or research facilities, call the New Departure Sales Engineer in your area or write Dept. K-12.

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NOTHING ROLLS LIKE A BALL

Direction Finder May Alter Alinement Concepts

NAA Autonetics' portable device could replace conventional methods of determining azimuth-reference base lines

by Fred Hunter

LOS ANGELES—A field-use direction finder which is portable, quick and easy to operate, and at the same time highly accurate may solve a long-time problem of missile launchers, mobile radars and other angle-calibrated equipment.

Designed to replace conventional surveying, celestial and magnetic methods of determining an accurate azimuth-reference base line, ABLE, developed by Autonetics, a division of North American Aviation, Inc. may trigger a major reorientation of alinement concepts.

Celestial alinement equipment requires a fix on a particular star and thus is good only at night in clear weather. Magnetic alinement methods find true north through the long and roundabout process of first locating magnetic north. Then, through consultation of declination tables, a basis for the determination of true directions in azimuth is obtained. Both celestial and magnetic alinement require entire teams of surveyors, who, to attain the necessary skill, must undergo rigorous and expensive training programs. Even with trained teams, these methods take hours for accurate base line determination.

• **By day or night**—ABLE, on the other hand, functions by day or by night, and in all kinds of weather. It requires but a single operator, and in only 10 minutes this operator can be trained to perform the entire alinement procedure. At middle latitudes, determination of an accurate base line is accomplished with ABLE in approximately 15 minutes; at latitudes between 60 and 70 degrees, a slightly longer period is required to obtain equivalent accuracy.

ABLE imposes no tactical restrictions, since it does not necessitate major revamping of missile-firing or equipment-positioning procedures (with the attendant expense and rigorous training program requirements).

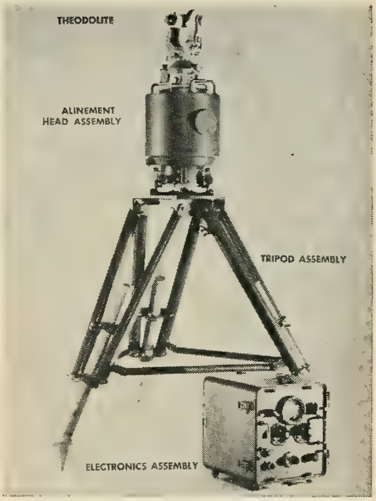
With ABLE, a mobile radar crew need not wait for the passage of inclement weather in order to take a "fix" on Polaris. By the same token, a rocket-launching group, with only a single hour to move into position, erect and aim the launcher, and then move out to escape retaliation, need no longer be dependent on slow surveying methods to determine local directions. These two examples are typical of the numerous applications in which accurate angular reference can be conveniently supplied by ABLE.

• **Three assemblies**—The basic components of ABLE are three assemblies: alinement head, electronics, and tripod. In the portable, general purpose version, the three assemblies make up a single 100-lb. piece of equipment. For practically all positioning, aiming, and surveying applications, this general purpose package—in conjunction with a standard theodolite or transit—is functionally suitable. In many cases, however, such as with missile-launching equipment or radar antenna alinement mechanisms—it may prove more practical for the alinement head and electronics assemblies to be physically integrated into the equipment requiring alinement. In these cases, easy-reading mechanical dials can often replace the theodolite.

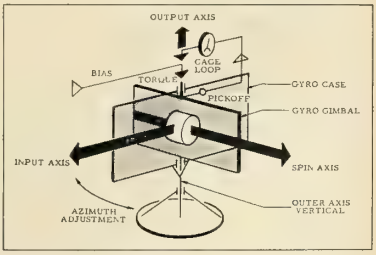
The principles upon which ABLE functions are simple and familiar.

A high-quality, single-axis gyro (located in the alinement head) produces alinement signals. The electronics assembly interprets these signals and, by means of a dial indicator, shows the operator the necessary adjustments for bringing the gyro input axis into alinement with true east-west. The true east-west line thus established by ABLE is then read out with the theodolite and serves as a base line for the accurate determination of any desired direction in azimuth.

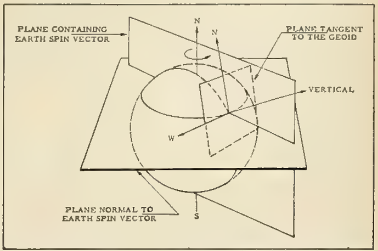
ABLE has much to offer in in-



BASIC ELEMENTS of ABLE: alignment head; electronics; and tripod.



SINGLE AXIS gyro showing input, output and spin axes.


N
N
PLANE CONTAINING EARTH SPIN VECTOR
PLANE TANGENT TO THE GEOID
VERTICAL
W
PLANE NORMAL TO EARTH SPIN VECTOR
S

WHEN INPUT axis of gyro is horizontal, axis must be parallel to true E-W line.

creased alinement accuracy and reduced alinement time for the boresighting of radar antennas.

Conventional methods employ either magnetic compasses and declination tables, or optical equipment and an ephemeris. Sometimes one method is used to double check on the other. By either method or by their combination, accuracy cannot be relied upon for precise boresighting.

- **Time consuming**—A magnetic compass is normally used to find magnetic north in daytime alinement. The compass reading, of course, must be corrected by consultation of the declination tables to determine true geographic north. To boresight a radar antenna, a corner reflector is mounted in line with true north, and the antenna is mechanically rotated until the reception of an echo from the reflector tells the operator that the radar beam is centered on true north. All this takes hours.

Sometimes the daytime alinement is either replaced or checked by celestial methods.

If the night is a clear one, the alinement crew sights on Polaris with a telescope. When Polaris has been sighted, the operators must determine the azimuth component of the star's actual location by study of a complicated ephemeris. Accuracy with celestial methods is dubious, not only because of the patent possibilities for human error, but because of the shimmering of the image beneath the telescope cross hairs due to variations in atmospheric density, winds, etc. If the night is completely clouded, the expensive equipment must stand uselessly idle.

In remarkable contrast to these slow, dangerous, and comparatively inaccurate conventional methods, are the simplicity, speed and precision of ABLE, with an alinement time measured in minutes and in an almost unbelieveable accuracy in base line determination.

For automatic alinement of the azimuth axis of the antenna, ABLE can readily be integrated, with minor modification, into the radar system.

Other fields for employing ABLE lie in the alinement requirements of ground controlled intercept (GCI) and missile-positioning and launching operations.

For GCI service, the rapidity with which ABLE can be set up and operated offers an advantage of inestimable importance. Its primary contribution to GCI is found, however, in the highly precise common geographic reference which it provides for the early-warning or acquisition radar and the controlled interceptor aircraft.

The course (vector) provided the interceptor aircrew by the GCI equipment brings the interceptor to a point at which radar contact can be made with the target. To reach this point, the aircrew is supplied ground-controller information concerning the approximate elevation, bearing, speed, and range of the target, as well as of the interceptor. The necessity for extreme accuracy in this information is enhanced by the tremendous speeds and maneuverability of modern aircraft. With the reference furnished by ABLE, the GCI information is accurate and dependable. Because of ABLE's speed of operation, the information can be kept dependable through quick, frequent alinement checks.

In the positioning and aiming of missiles and rockets, ABLE's speed and accuracy could prove invaluable. The ABLE components can be physically integrated into the missile-launching equipment. Total alinement time, depending on latitude, can be as little as 10 minutes. For anti-missile-missiles, the advantages of this capability for almost instantaneous response to early warning of enemy ballistic missile attack is obvious.

- **Meets requirements**—To perform satisfactorily, a ballistic missile must be correctly aimed to within a few tenths of a degree. To hit a target as large as the moon, a rocket must be properly positioned to within a half of a degree. In either case, ABLE's precision is more than sufficient to meet the requirements.

The gyro used in the ABLE system is known as a "single-axis" gyro because its outer case contains only one gimbal. The "spin axis" of this gimbal is defined by the rotor spin bearings; the other axis of the gimbal, termed the "output axis" is defined by the bearings in which the gimbal rotates within the case. The "input axis" is defined as being orthogonal to both the spin axis and the output axis.

In the ABLE configuration shown the gyro behaves as an extremely sensitive rate-gyro. If the case of this gyro, through its connection with the earth, is caused to have an angular rate of rotation about the gyro input axis, the gyro gimbal tends to precess (rotate) about the output axis. The pickoff, sensing a minute displacement of the gimbal with respect to the case, produces an electrical restraint—that is, a torque—about the output axis, which prevents the rotation and at the same time indicates the magnitude of the required restraint.

When the gyro is so positioned with respect to the earth that the component of earth rate lying along the gyro input axis is zero, the gimbal tends to remain stationary with respect to the case and no restraint is required.

In operation, the gyro case position is adjusted in increments about the outer vertical axis until the requisite null condition is achieved. The indicator needle is then centered at zero, and the ABLE operator knows that the input axis is at right angles to the earth rotation vector. If, at the same time, the input axis of the gyro is horizontal, the axis must be parallel to a true east-west line. A true east-west line is defined as the intersection of a plane tangent to geoid with a plane normal to the earth spin vector. If the input axis of the gyro is horizontal, it must lie in a plane tangent to the geoid and, since rotation about the input axis is zero, the axis must also lie in a plane normal to the earth spin vector.

Any gyro is characteristically subject to inherent bias torques acting on the gimbal. These torques are attributable to mechanical stresses in electrical connections, magnetic field effects, etc.

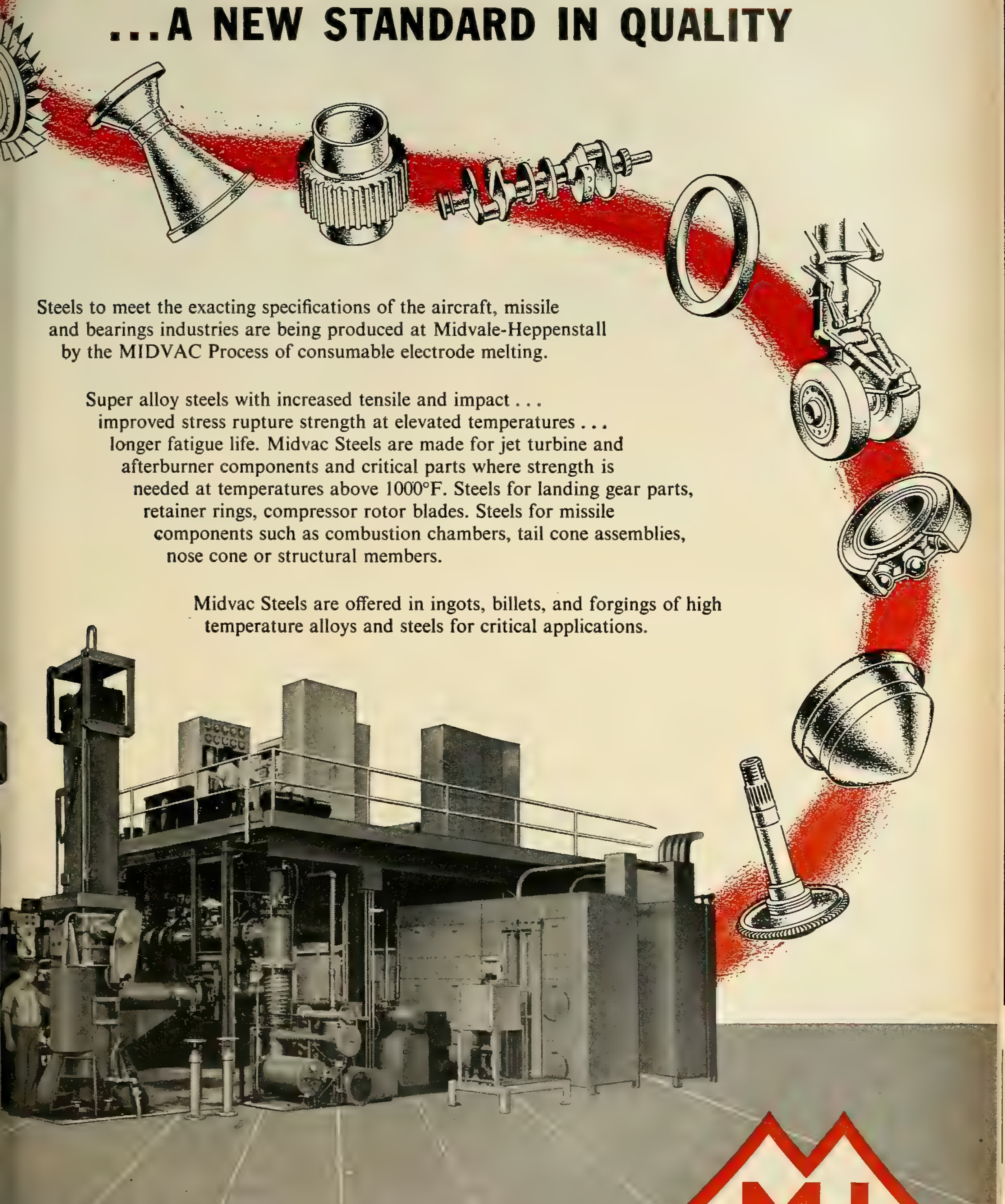
In ABLE, all torques upon the gyro input axis other than those due to earth rotation are measured and cancelled by means of a self-contained bias-compensation circuit. Thus, when the gyro is so positioned that the influence of earth spin upon the gyro is eliminated, the gyro input axis is alined with true east-west and serves as a precise reference for the determination of any desired direction in azimuth.

The constant and repeatable precision of the system is maintained through the effective cancellation of internal bias and, also, through the extreme stability of this bias.

- **Accuracy**—Any electronic equipment is only as useful as it is reliable, and ABLE's remarkable accuracy and high-speed operation is attained by the exclusive use throughout of standardized designs based on actual testing and operating experience. Both purchased parts and components developed at Autonetics have been subjected to extensive test and inspection programs.

The high-precision gyro—which is the heart of the ABLE system—was developed under the cognizance of the Weapons Guidance Laboratory, Wright Air Development Center, Wright-Patterson Air Force Base. These gyros are now in quantity production a Autonetics. The ABLE electronic circuitry has been fully proved under other programs. All circuits are transistorized.

Self-check features in ABLE make possible the ready detection and isolation of malfunctions, and replacemen of the gyro-optical subassembly or o any of the plug-in cards can be accomplished in a matter of minutes



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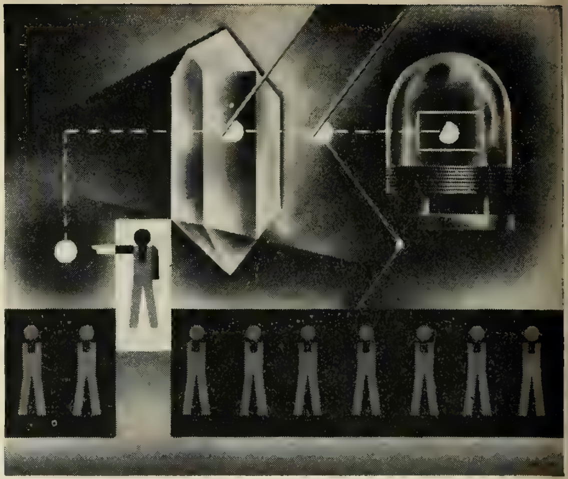

AUTOMATION Bulova R&D designed mechanized plant and equipment for Signal Corps goal of 10,000 perfect quartz crystals per 8 hour shift —with 1/10th the manpower. From systems analysis through equipment development, Bulova engineers devise industrial and military facilities for automatic production of electronic components and ordnance items.

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Time, mass, length... the age-old concepts man relies on as he enters the Age of Space.

Time alone is unique. Its accurate measurement demands the highest order of precision in the design and manufacture of electro-mechanical devices.

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National Cash Register glass rod switching and storage element is so fast that top speed is unknown

Magnetic Unit Uses Extremely Low Power

by Raymond M. Nolan

PHILADELPHIA—National Cash Register's Electronics Division has developed a switching and storage element which works so fast that its top speed is unknown.

The device, a glass rod with a magnetic coating, has had switching speeds of 4 millimicroseconds measured in the laboratory, but production models have not had their speeds timed.

Power required to store a "bit" of information is only 20 thousandths of a watt, and it is possible to link thousands of the rods together.

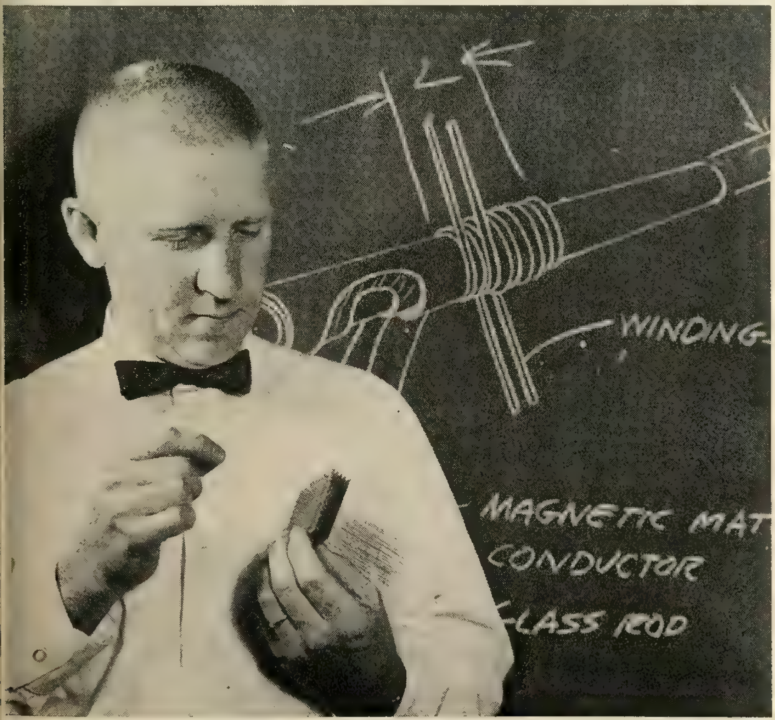
The rod reportedly operates reliably at temperatures 300 degrees F higher than conventional components. In the laboratory, the rod has been operated in the coincident current mode from minus 100 degrees C to plus 200 degrees C. In the word-ordered mode, this temperature range can be extended upward.

Switching has been accomplished continuously at a five megacycle repitition rate without adverse heating effects. The hysterisis loop on the rod's magnetic coating is extremely square, showing a ratio of better than 0.95.

• **Magnetic coating**—The new unit is about 15 thousandths of an inch in diameter. It is given a magnetic coating by an electrochemical process developed by NCR. The length of the rod can be varied, depending on the storage capacity desired. A small winding of wire around the rod stores the information. The compact size of the rod cuts the space required for storing information, with 8000 "bits" being stored in a rod memory system the size of a cigarette package.

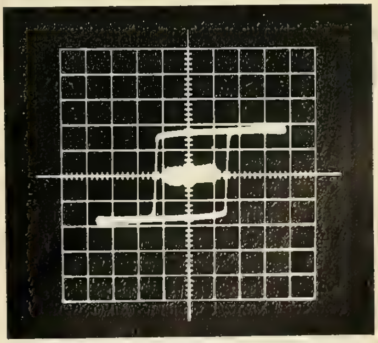
It is possible to wind 10 bit-positions per linear inch along the rod without mutual interference. These windings of very fine wire are placed on the rod in a solenoid-like manner with successive windings superimposed. At the present time, packing density is 1000 bits per cubic inch, although this is not an electrical limit.

• **Memory matrices**—A single magnetic element for a coincident current memory requiring two inputs, an inhibit winding and a sense winding would consist of four separate single-layer concentric solenoids over the rod. Memory matrices each consisting of many solenoids can be stacked and simultaneously threaded with the rod.



DONALD A. MEIER, inventor of the magnetic rod, inserts a tiny element into memory assembly. Blackboard shows construction features.

MAGNETIC ROD memory element. Photo shows relative size.



SQUARE HYSTERISIS loop of magnetic rod. Ratio is better than 0.95.

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SYSTEMS ENGINEER to develop complex devices in fields of servo-mechanisms, radar, or computers, and integrate these elements in weapons systems. Must have 3 to 5 years' experience in such activity and two years' experience in over-all systems analysis. Assignment involves design and analysis of closed-loop systems, consisting of inertial and radar equipment, display materials, and digital or analog computers.
Qualifications: B.S. or Advanced Degree in E.E. or A.E.

INERTIAL GUIDANCE ENGINEER to assume broad project leadership in the planning and control of development projects. Must have 3 to 5 years' experience in servo-mechanisms or development of complex devices for military applications, including 2 years as technical leader of inertial guidance system development. Must have experience in astro-compass, with ability to analyze relationship of inertial equipment with bombing and navigation computer.
Qualifications: B.S. or M.S. in E.E. or Physics.

RADAR ENGINEER to analyze ultimate limits of present techniques and develop new concepts of providing topographical sensors for advanced airborne and space systems; to design airborne radar pulse, microwave and deflection circuitry; to analyze doppler radar systems in order to determine theoretical accuracy and performance limitations.
Qualifications: B.S. or Advanced Degree in E.E. and 3 to 5 years' experience in radar system development, including display equipment and circuits, control consoles, and doppler or search radar design.

CONTROL SYSTEM ANALYST to perform physical and mathematical analyses needed to solve complex inertial control problems with real-time digi-
tal computers. Applications in area of b
navigation systems, missile systems, spe
pose computer systems such as DDA.
Qualifications: M.S. or Ph.D. in Physics o
fields with strong math minor and up to
experience.

COMPUTER ENGINEER to undertake lo
sign of airborne digital computer eq
transistorizing computer circuitry for
weight reduction. Assignment entails: Me
tion of computer circuitry and packagi
preting problems for solution with the
Qualifications: B.S. or Advanced De
Engineering or Physics and 3 to 5 years
ence in design of digital or analog c
equipment. Experience desirable in t
technology, computer logic, programmin
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Sylvania Working at MASER Miniaturization

New York—Development of the MASER (Acronym for microwave amplification by stimulated emission of radiation) is expected to take a long stride forward because of work now in progress at Sylvania Electric Products.

Dr. Robert M. Bowie, vice president of Sylvania Research Laboratories, a division of the company, recently announced that the Labs are now engaged in a program to "ruggedize, miniaturize and package" the MASER so that it may be used initially in military applications, and ultimately in industry and peacetime research.

Dr. Bowie described the Sylvania program at a conference held at the Research Laboratories at which Sylvania and Arthur D. Little officials dedicated the 100th Collins cyrostat, a device manufactured by Little which liquefies helium gas at a temperature near absolute zero. The liquid helium is used to cool the MASER crystals and their surroundings, which depend for operation on the presence of temperatures close to absolute zero.

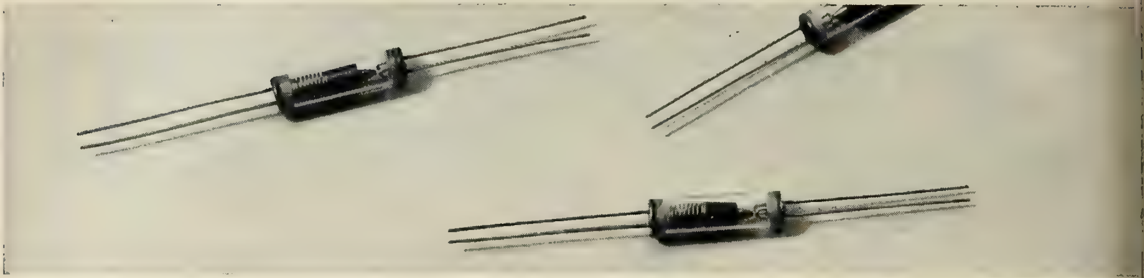
The Sylvania concept of a packaged MASER system would include as integral parts a small, built-in cooling system, and a small permanent magnet instead of the huge electro-magnets now used in laboratory systems.

However, the completion of a prototype packaged MASER system by Sylvania is still about one-and-one-half years away and there are a number of problems still to be solved before a working miniaturized system can be demonstrated, according to Dr. Bowie. He added though, that "we are looking forward to the day when such a system, simplified and easy to operate, will lend new eyes and immeasurably improved defenses to our Armed Forces. It could be put in the field in a radar system, operated by a technician, and accomplish feats of detection not dreamed of with present-day radar."

Dr. Bowie estimates that if a MASER were installed in a conventional radar system, it would increase the range of the system from two and one-half to seven times. Conversely, at closer target ranges, the MASER would produce the same picture as a conventional system, with substantially less transmitter power.

In addition to the packaging program, Sylvania has a four-point MASER program in progress at the Research Laboratories. The program includes the study of existing MASER materials and the search for other materials with improved characteristics.

HUGHES THERMAL RELAYS



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With unusual speed of action, firing signal triggers the release of constrained contact... contact closes upon fixed contact point... switch circuit becomes permanently closed.

In a typical application, 3.0 volts DC applied to a firing circuit of 1.2 ohms fires within 0.3 seconds.

For additional information please write: Hughes Products, Marketing Department, International Airport Station, Los Angeles 45, California.

SPECIFICATIONS

MECHANICAL—Body Size: Maximum diameter 0.252"; length .920". Total weight: Less than 0.1 oz.

ELECTRICAL—**Before Firing:** Insulation resistance is greater than 200 megohms. Minimum breakdown voltage 600 volts.

Firing: 2 volts minimum required. Actual voltage dependent upon closing time desired.

After Firing: Circuit resistance less than 0.3 ohm.

ALTITUDE—Any.

OPERATING TEMPERATURE: −55°C to +125°C.

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PMR Could Cost Billions

by **Robert Mount**
Special m/r correspondent

POINT MUGU, CALIF.—Cost of de- eloping the Pacific Missile Range ould run into billions of dollars over e next 15 years, according to Rear dmiral Jack P. Monroe, PMR com- ander.

"Of course," he said, "we don't ow what programs are coming, or en what programs authorities may be inking about over the next few years hich might logically require firings er the Pacific.

"It depends whether all contem- ated projects are approved, whether ey are assigned to the PMR, and hat the pace of the work will be.

"It could cost billions to develop e range over the next 15 years if all ontemplated projects should go rough and be assigned to the PMR a normal development period.

"In addition, operation of the range ould amount to several hundred mil- ons of dollars a year, subject to the me qualifications I've mentioned."

• **First ship assigned**—The first nge ship assigned is the Pvt. Joe E. ann, now docked at Port Hueneme, ear the Naval Missile Center Point ugu, which is range headquarters.

Also berthed is the converted LST ing County, which contains a "piggy- ack" mockup of the bow of the nu- ear sub, Halibut, plus a complete uplicate of the *Regulus II* missile sys- m aboard the Halibut. The King ounty will be used for *Regulus II* rings and for training of future mis- le-submarine crews.

Port Hueneme is also home port r the USS Norton Sound, the Navy's rst experimental guided missile ship, hich has operated in waters off Point ugu for nearly 10 years, with occa- onal long cruises for special projects.

The submarine Grayback, which rries two *Regulus II* or four *Regulus* missiles in her deck hangars, is pres- ntly completing her shakedown cruise. ut during her first visit to Port ueneme, she successfully conducted e first sea-launching of a *Regulus II* an inland point on the Wendover orridor of the PMR. Grayback is ex- ected back at Port Hueneme some- me in January.

In addition to PMR headquarters Point Mugu, the range includes the aval Missile Facility at Point Ar- uello, almost 100 miles to the west of nge headquarters, and San Nicolas land, 62 miles southwest of Point ugu.

These three sites presumably would be the key instrumentation units for the ultra-sensitive radars which will sweep the range.

• **Established in 1946**—Point Mugu was formally established as a missile center in 1946, and has utilized special facilities on San Nicolas Island in conjunction with early missile development launchings from the main pad at Point Mugu and from vessels in the small Sea Test Range off Ventura County's coast.

At NMF Point Arguello, there are presently no launching sites.

Initial construction of photographic, technical administration and instrumentation facilities at NMF Point Arguello has just begun.

Top military officials have said on numerous occasions that Point Arguello, because of its physical features, is destined to become ultimately this nation's primary satellite launching site.

The Air Force has already achieved operational capability with ballistic missiles at Vandenberg AFB, just across the Santa Ynez River from NMF Point Arguello. Here the *Thor* pads are completed and *Atlas* pads soon will be ready for firings.

Vandenberg AFB is separate from the PMR, but it will undoubtedly be utilized for early PMR work until other facilities for as yet undisclosed projects of ARPA, NASA and private contractors are constructed at the nearby NMF.

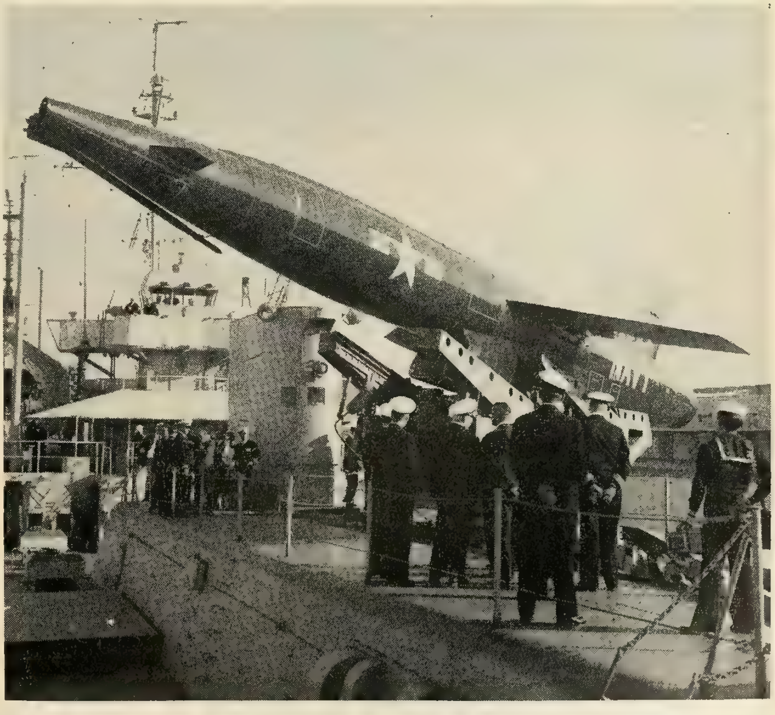
The PMR, acting as a service agency for NASA, ARPA, and other government units, will eventually control all of this nation's satellite launchings on polar and equatorial orbits.

Admiral Monroe says, "The Pacific Missile Range is this nation's last opportunity to build a range from the ground up.

"Because of this, we are studying the entire missile and rocket industry, learning what programs are coming, and projecting these programs into future needs.

"We are trying to design the range, as it is developed, so that it will have the capability to match the anticipated needs in the years to come."

Admiral Monroe foresees a time when the instrumentation facilities of the PMR, the Atlantic Missile Range, and the White Sands Missile Range will be tied into a common network, so that each range can assist in such projects as satellite, ballistic missile, and space vehicle tracking with high efficiency and minimal delay in analyzing and interpreting data transmissions.



FIRST *REGULUS*-ARMED LST is the USS King County, an experimental vessel serving the Pacific Missile Test Range. It will test the missile launching system and will train submarine crews.

Bloodhounds ready for launching during acceptance trials at Woomera

For Britain’s

Approaching full operational status with the RAF as ma
stay of Britain’s air defence.

Adopted by Sweden after exhaustive consideration of surfa
to-air guided missile systems available throughout the wo

Proved in many hundreds of test firings.

Bristol/Ferranti Bloodhound forms the world’s most effect
defence system now and for many years to come.

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DEFENCE

ity forbids publication of full details, but the
ing facts about Bloodhound can now be given:—

. The Bloodhound is powered by two Bristol ramjets
jet engine with no moving parts. Ramjets ensure
and range flexibility, burn kerosene, are simple and
handle.

g system. Semi-active: i.e., ground crew directs
beam on to approaching target which is reflected to
ver in Bloodhound missile.

ensures highest accuracy—regardless of range.
s may be fired singly or in salvoes using only one

ne. Employs unique and advanced monoplane
wing configuration—two advantages: quicker and more precise response, as well as greater accuracy of interception—superior at high altitudes; this configuration was selected at initial design stage to embody maximum development potential.

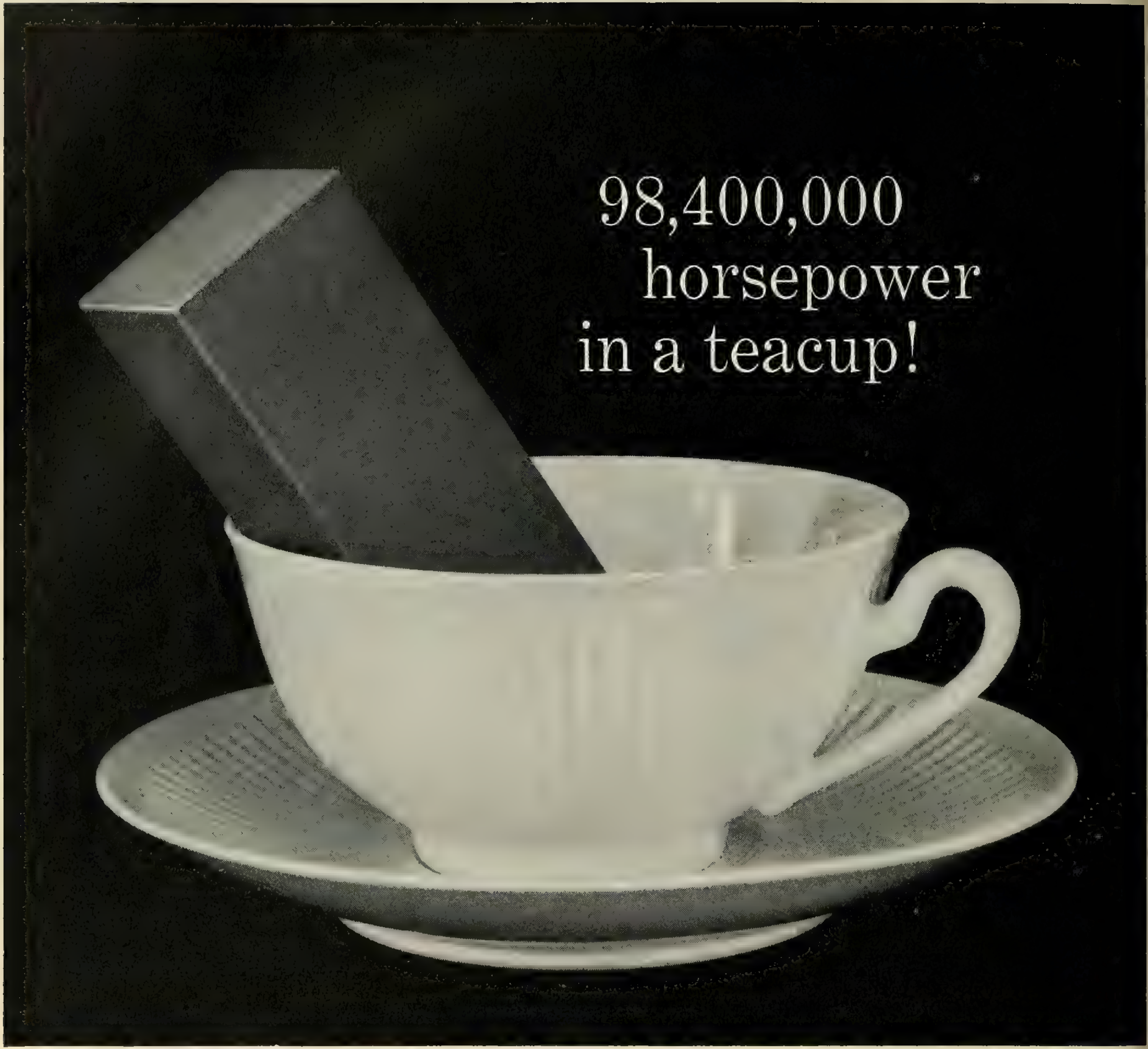
BRISTOL/FERRANTI

Bloodhound

GUIDED WEAPON SYSTEM

BRISTOL AEROPLANE CO (USA) INC
400 PARK AVENUE, NEW YORK 22, NY

design and construction by Bristol. Guidance and control by Ferranti. System sales organisation Bristol Aircraft Limited



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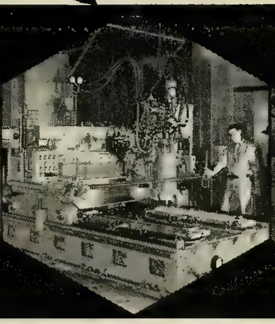
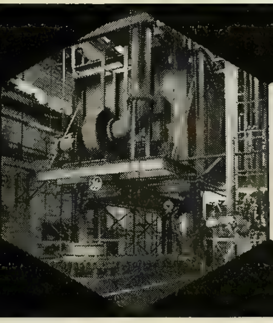
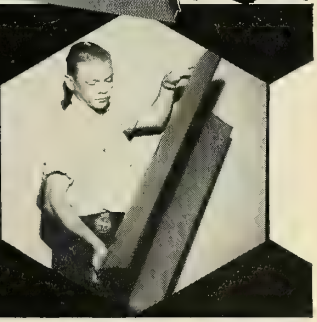


Special high-speed machinery . . . advanced fabricating techniques.



Large capacity precision brazing furnaces.



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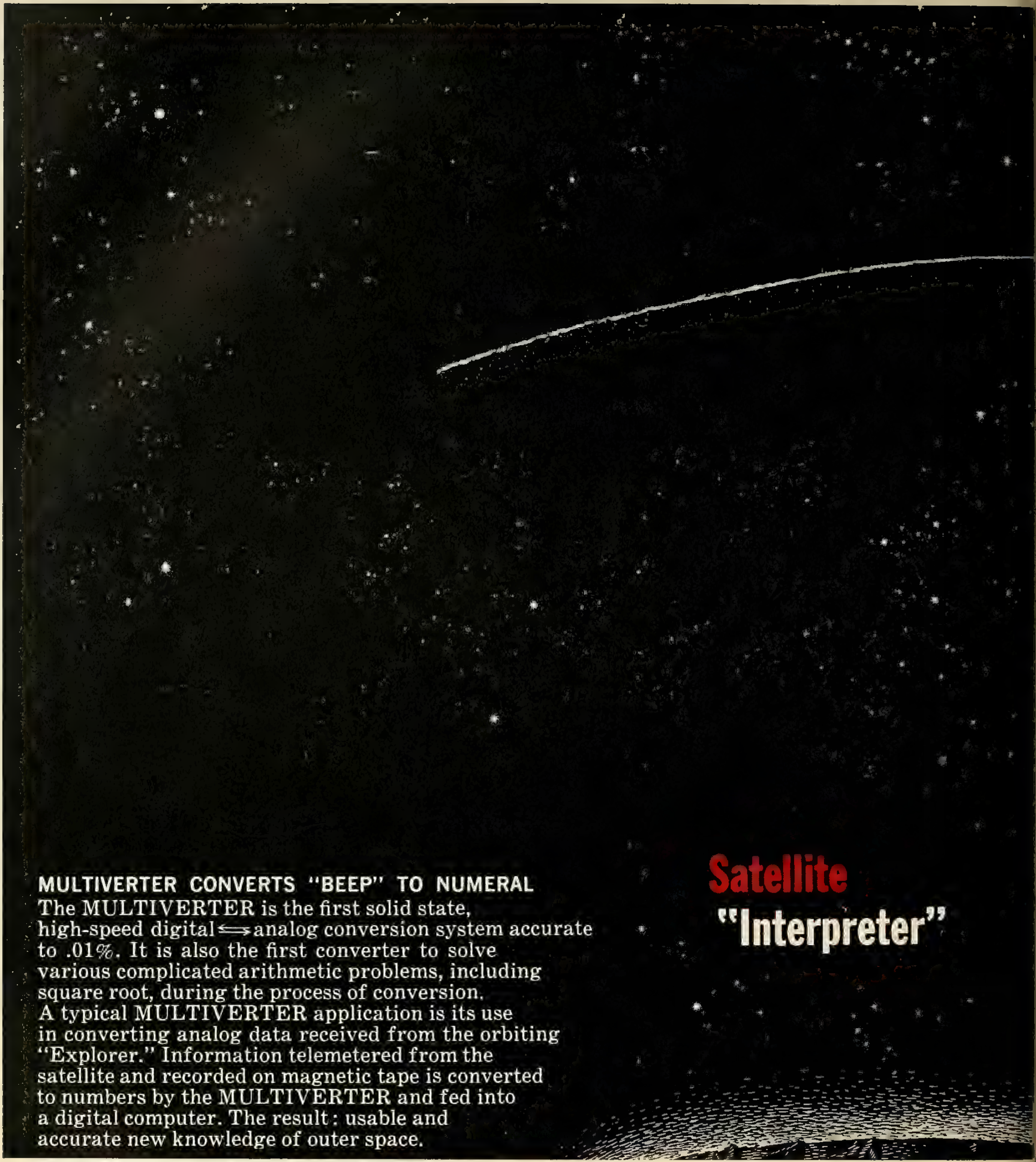
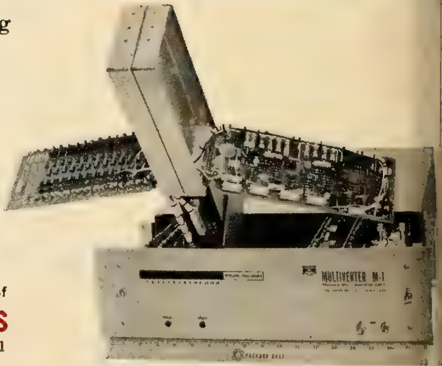


Satellite "Interpreter"

MULTIVERTER CONVERTS "BEEP" TO NUMERAL
The MULTIVERTER is the first solid state, high-speed digital⟺analog conversion system accurate to .01%. It is also the first converter to solve various complicated arithmetic problems, including square root, during the process of conversion. A typical MULTIVERTER application is its use in converting analog data received from the orbiting "Explorer." Information telemetered from the satellite and recorded on magnetic tape is converted to numbers by the MULTIVERTER and fed into a digital computer. The result: usable and accurate new knowledge of outer space.

ENGINEERING BEYOND THE EXPECTED
The need for highly accurate measurement in an accelerating technology called for a solid state converter with an accuracy of .01% and a speed of four microseconds per bit. The MULTIVERTER and related accessories resulted. One immediate application has been the interconnection of Packard Bell's TRICE, the first incremental differential analyzer to operate in real time, with various analog systems. Other applications include Missile Impact Prediction, Coordinate Conversion, Orbit Prediction and Solid State Automatic Checkout Systems.



Packard Bell Computer Corp.,a subsidiary of

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12333 W. Olympic Blvd., Los Angeles 64, Calif., BR 2-2171

when and where

DECEMBER

Plas-Tech Equipment Corp., Symposium on High Speed Testings, Sheraton-Plaza Hotel, Boston, Mass., Dec. 8.

Mid-American Electronics Convention, sponsored by Kansas City Section, Institute of Radio Engineers, Municipal Auditorium Arena, Kansas City, Mo., Dec. 9-11.

American Astronautical Society, Fifth Annual Meeting, Hotel Statler, Washington, D.C. Meeting will be held in conjunction with the 125th Annual Meeting of the American Association for the Advancement of Science, Dec. 27-30.

JANUARY

Reliability and Quality Control in Electronics, Fifth National Symposium, Bellevue-Stratford Hotel, Philadelphia, Pa., Jan. 12-14.

Society of Automotive Engineers, Annual Meeting and Engineering Display, The Sheraton-Cadillac and Hotel Statler, Detroit, Jan. 12-16.

Fifth Annual Radar Symposium (classified), Rockham Bldg., University of Michigan, Ann Arbor, Mich., Jan. 27-29.

Society of Plastics Engineers, 15th Annual Technical Conference, Hotel Commodore, New York, N.Y., Jan. 27-30.

Armour Research Foundation, Fifth Annual Midwest Welding Conference, Illinois Institute of Technology, Chicago, Ill., Jan. 28-29.

Nuclear Fuel Elements, First International Symposium jointly sponsored by Columbia University and Sylvania-Corning Nuclear Corp., Columbia University, New York City, Jan. 28-29.

FEBRUARY

14th Annual Technical and Management Conference, Reinforced Plastics Div., Society of the Plastics Industry, Inc., Edgewater Beach Hotel, Chicago, Ill., Feb. 3-5.

IRE, AIEE 1959 Solid State Circuits Conference, University of Pennsylvania, Philadelphia, Pa., Feb. 12-13.

MARCH

IRE, AIEE and Association for Computing Machinery, 1959 Western Joint Computer Conference, Fairmont Hotel, San Francisco, Calif., March 3-5.

propulsion engineering

by Alfred J. Zaehringer

Atomic ramjet or turbojet might be vastly more economical to run than the boron fuel counterpart. Atomic ramjet fuel (U-235) operating at only 1% energy conversion would deliver about 25,000 Btu per dollar. Boron fuel at 100% energy conversion would give only 3,000 Btu per dollar. Phillips Petroleum propulsion test reactor recently hit a fuel conversion of 18% with uranium fuel elements. In 100% conversion of uranium fission process, heat delivery is 34 billion Btu lb. Big problem with atomic fuels is still radiation. If radiation can be safely handled, the future of any chemical fuel would seem quite dim for economical flight within the atmosphere. Thus, boron fuels, are to be looked on as an interim development that may never be used for commercial operations.

Rocket engine which Aerojet is fabricating for second stage *Vanguard* and *Pioneer* is of unusual construction. A solid metal injector plate is used. Chamber itself is made of stainless steel wrapped with wire. Nozzle is made of brazed aluminum tubing. Propellants are fuming nitric acid and UDMH. Chamber pressure is about 200 psi.

LOX will probably be used in both the 1 meg Air Force and 1.5 meg Army liquid rocket engines. Fluorine and other exotic combinations, probably for the next 2-5 years, will be relegated to use in smaller thrust level second and third stage combinations provided the new liquid storables (nitrogen tetroxide or perchloryl fluoride) and high-energy exotic solids do not take over. Fluorine, however, may appear in the large second generation engines some five years hence.

New lease on life for ozone? A chemical team in Argentina indicates both a reaction and a stabilizing effect when pressurized ozone comes into contact with fluorine. Fluorine does not react directly with the ozone but only with free oxygen or activated O_2 molecules. Effect of chamber walls is important. Liquid ozone-liquid fluorine mixtures might be quite stable and easier to handle than either separately.

New solid programs for ARPA may take the following technical approaches: American Cyanamid could work to improve polyesters, melamines, and other fuel-binders; Dow will investigate magnesium metal powder additives and magnesium metal-organics; Esso on formulation of new fuels from petroleum; and Minnesota Mining & Mfg. on fluorine yielding fuels. US Borax is already working on inorganic (perhaps boron) polymers for fuelbinders.

Solid boron exotics are in the research stage at Callery Chemical Co. The firm, with close ties to Thiokol, will soon set up a pilot plant at Lawrence, Kan., or Muskogee, Okla. to polymerize diborane to yield solid fuels. The company appears less optimistic about boron liquid for rockets than for solid rockets. Decaborane or higher analogs will be alkylated to give stable, high-energy solid fuels.

Aluminum metal in propellants could lead to increased detonation possibilities. Moreover, French researchers report that with a given composition, the detonation velocity increases as the propellant diameter increases. Aluminum powder is currently being tried in both double base and composite solids to increase combustion temperatures. The French findings indicate the criticality that might result in scaling up solids using aluminum additives. Troubles with double base solids already point this way.

Soviet solid propellant work is being done at the Mendeleev Institute in Moscow. Work on nitroglycerine and diglycol dinitrate has been reported.

contract awards

AIR FORCE

By Headquarters, Air Force Office of Scientific Research, Air Research and Development Command, Washington, D.C.:

$41,950—**California Institute of Technology,** Pasadena, Calif. for research on secondary flows in axial compressor stages.

$128,817—The Regents of the **University of California,** Berkeley, for research on internal stresses in ceramic bodies, and for continuation of research on ductile ceramics.

$46,000—The Trustees of **Princeton University,** Princeton, N.J. for research on molecular problems in heat and mass transfer.

$77,870—**The University of Chicago,** for research on nuclear emulsion research with high energy accelerators.

$50,000—The Regents of the **University of Calif.,** Berkeley, for continuation of basic research in microwave electronics.

$49,951—**Westinghouse Electric Corp.,** Baltimore, Md. for research on methods and techniques for space flight.

$45,234—**Atlantic Research Corp.,** Alexandria, Va. for experimental study of turbulent flames in a two-dimensional open burner.

$110,000—Board of Governors, **Wayne State University,** Detroit, Mich. for research on surface phenomena in semiconductors and the growth of semiconductor crystals.

By Headquarters, Air Force Cambridge Research Center, ARDC, Bedford, Mass.:

$31,137—**Control Data Corp.,** Minneapolis, Minn. for magnetic drum information filter system.

$54,789—**Sylvania Electric Products, Inc.,** Bayside, N. Y. for developing a method of analyzing concentrations of impurities in silicon carbide.

$45,057—**Metalab Equipment Co.,** Norbute Corp., Hicksville, N.Y. for radiation laboratory equipage complex to be used in radiation laboratory research.

ARMY

By Cleveland Ordnance District, Cleveland, Ohio:

$55,771—**North Electric Co.,** Galion, Ohio for cost plus a fixed fee contract for *Jupiter* intra-squadron communications systems.

By the Ford Instrument Co.:

$1.5-million—**The Engineering and Optical Division of the Perkin-Elmer Corp.,** Norwalk, Conn. for alignment theodolites to be used in conjunction with the *Jupiter* IRBM program.

By Corps of Engineers, Office of the District Engineer, U.S. Army Engineer District, Tullahoma, Tenn.:

$628,278—**H. E. Collins Contracting Co., Inc.,** Chattanooga, Tenn. for construction in gas dynamics facility, Arnold Engineering Development Center, Tullahoma, Tenn.

By U.S. Army Ordnance District, Los Angeles, Pasadena, Calif.:

$1,345,000—**California Institute of Technology,** Pasadena, for engineering research and development.

NAVY

By U.S. Navy Purchasing Office, Los Angeles, Calif.:

$48,730—**Electro-Mechanical Research, Inc.,** Sarasota, Fla. for telemetry system and components.

$127,598—**Associated Aero Science Laboratories,** Hawthorne, Calif. for personnel and services for performing data reduction analysis service at the U.S. Naval Ordnance Test Station, China Lake, Calif.

$87,510—**Applied Science Corp. of Princeton,** Princeton, N.J. for telemetering equipment ASCOP type M and components.

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advertisers' index

Aeronca Mfg. Corp. 47
Agency—Penn & Hamaker, Inc.

American Beryllium Co., Div.-Visioneering Co., Inc. 2
Agency—Gilmore-Rice Adv.

American Potash & Chemical Corp. .. 46
Agency—The McCarty Co.

Astrodyne, Inc. 12
Agency—Batten, Barton, Durstine & Osborn, Inc.

Avco Mfg. Corp., Crosley Div. 51
Agency—Benton & Bowles, Inc.

Bristol Aircraft Limited 44, 45
Agency—Young & Rubicam, Ltd.

Bulova Watch Co., Research & Development Laboratories, Inc. 38
Agency—Duncan-Brooks, Inc.

Burndy Corp. 10
Agency—Ted Gravenson, Inc.

Burroughs Corp. 16
Agency—Campbell-Ewald Co.

Caterpillar Tractor Co. 32, 33
Agency—N. W. Ayer & Son, Inc.

Diversey Engineering Co. 8
Agency—Roark & Colby Adv., Inc.

Dow Chemical Co., The 3
Agency—MacManus, John & Adams, Inc.

Food Machinery & Chemical Corp. .. 6
Agency—The McCarty Co.

Hughes Aircraft Co. 42
Agency—Foote, Cone & Belding

International Business Machines Corp. 40, 41
Agency—Benton & Bowles, Inc.

L.O.F. Glass Fibers Co. 11
Agency—Wade Adv. Agency, Inc.

McCormick Selph Associates 52
Agency—Compton Adv., Inc.

Midvale-Heppenstall Co. 37
Agency—A. E. Aldridge Assoc.

New Departure Div., General Motors Corp. 34
Agency—D. P. Brother & Co.

North American Aviation, Inc., Missile Development Div. 14
Agency—Batten, Barton, Durstine & Osborn, Inc.

Northrop Aircraft, Inc. 31
Agency—Erwin Wasey, Ruthrauff & Ryan, Inc.

Packard Bell Electronics, Technical Products Div. 48
Agency—Robinson, Jensen, Fenwick & Haynes, Inc.

Ramo-Wooldridge Corp. 25
Agency—The McCarty Co.

Ryan Aeronautical Co. 13
Agency—Batten, Barton, Durstine & Osborn, Inc.

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Agency—E. A. Korchnoy, Ltd.

Space Technology Laboratories, Inc. .. 28
Agency—The McCarty Co.

Temco Aircraft Corp. 5
Agency—Rogers & Smith Adv.

Vinco Corp. 26
Agency—Rolfe C. Spinning, Inc.

Westvaco Chlor-Alkali Div., Food Machinery & Chemical Corp. 18
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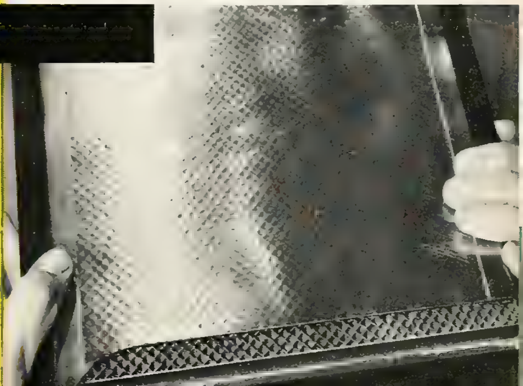

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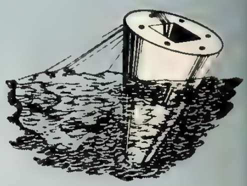

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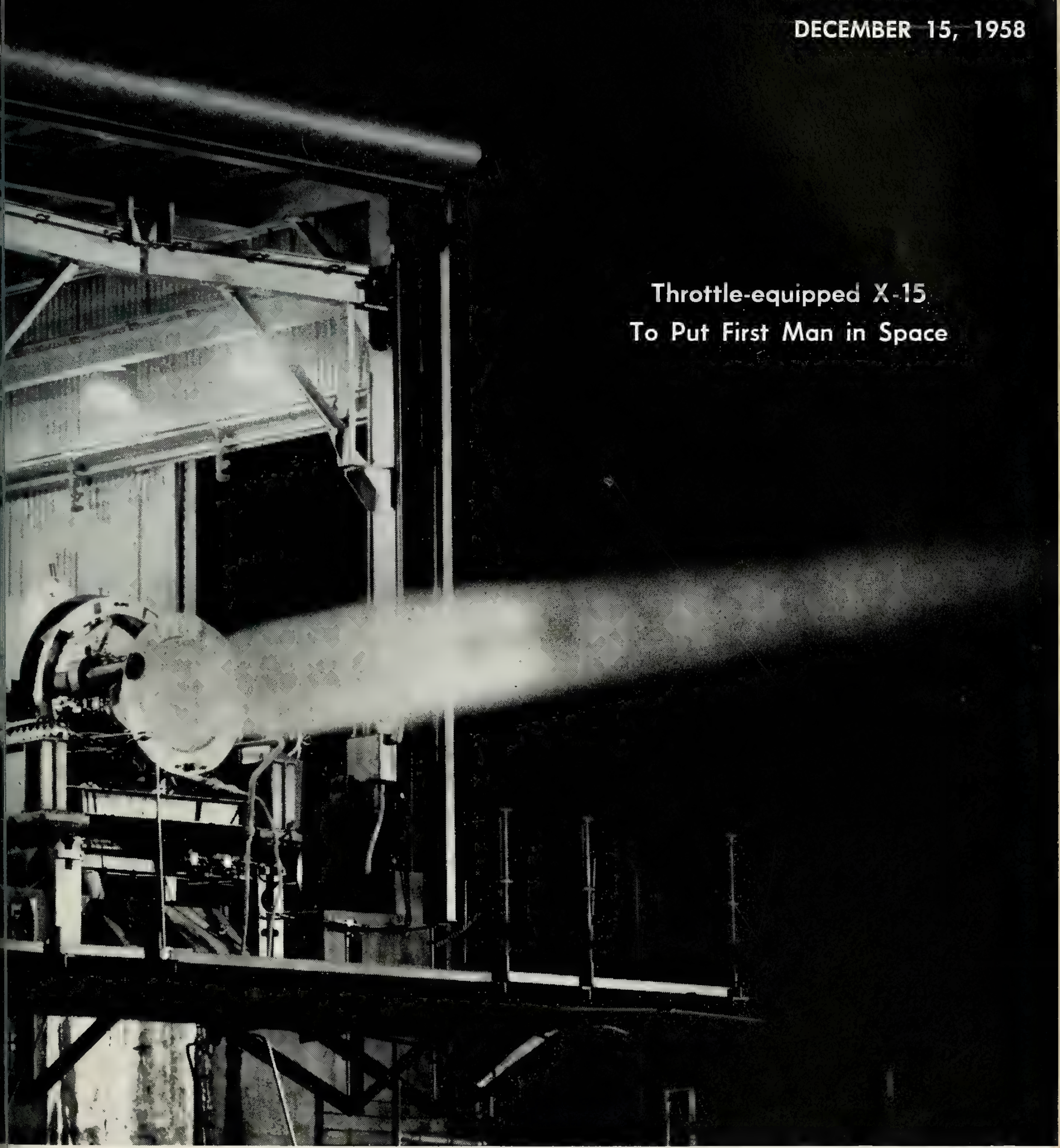
McCormick Selph Associates

HOLLISTER AIRPORT, HOLLISTER, CALIFORNIA

DECEMBER 15, 1958



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missiles and rockets

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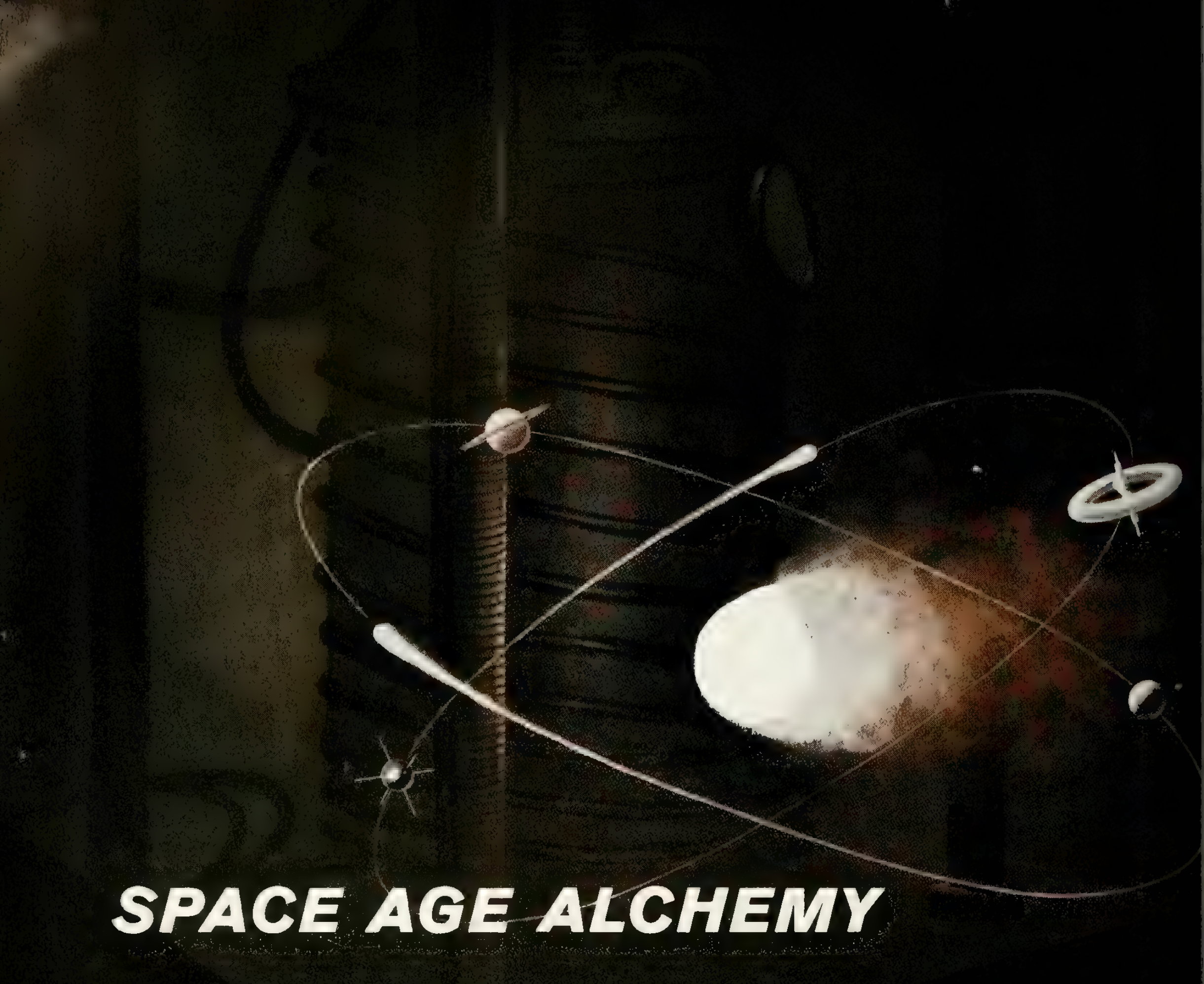

SPACE AGE ALCHEMY

New materials, capable of withstanding extremely high temperatures and encompassing properties that meet specific requirements are now being created at Servomechanisms' Research Laboratory. SMI's research has been in the field of solid state physics, wherein the study of basic atomic and molecular properties of matter has resulted in materials that can actually be designed to accomplish specific tasks. The challenging space age will depend heavily upon such techniques.

Major scientific break-throughs in the "State of the Art" have already resulted in new materials capable of operating at 500°C and new investigations indicate that this upper limit may be extended to 1000°C.

The above illustration pictures an experimental hot press, developed by SMI, for basic investigations into these new materials. The press subjects various compounds to 3,600°C and 6,000 PSI in a vacuum or inert gas.

These new advances are providing positive support to the ever-increasing requirements of the Department of Defense. The expanding Research Laboratory facilities are ready to assist you in your advanced scientific programs.

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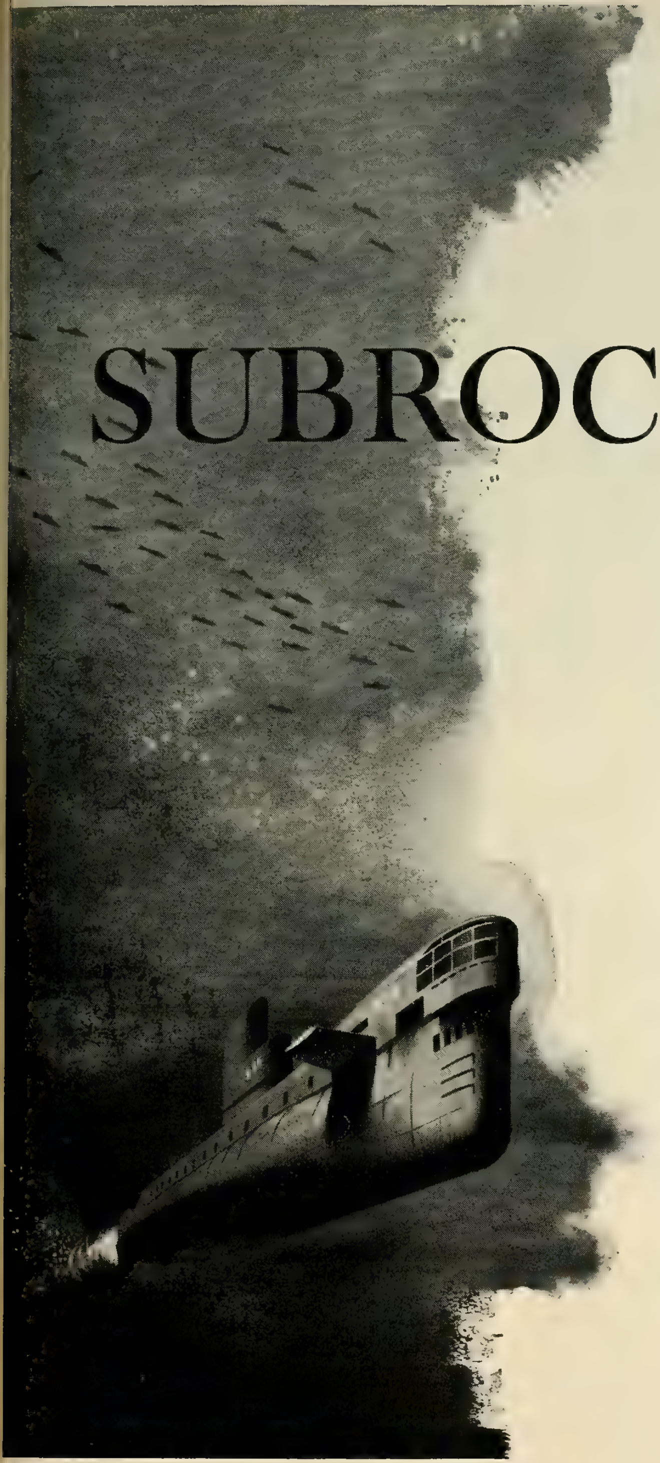

SUBROC

— new antisubmarine weapon system—will seek, strike and destroy lurking submarines at long range. Spearheaded by an underwater guided missile which can be fired from below the surface, this vital system — now being developed for the Navy's Bureau of Ordnance, under the technical direction of the Naval Ordnance Laboratory in Silver Spring, Md. — will use our existing underwater fleet as launching platforms.

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STEPS IN THE RACE TO OUTER SPACE

Assembling a station in space

This imaginative but technically accurate illustration shows a permanent satellite (center) being constructed in orbit around the earth. It generates its own heat and electricity from solar rays. Basic vegetation (such as algae) for oxygen as well as protein-rich foods are grown in hydroponic tubes in upper level "greenhouses."

New vistas in astronomy will be opened up by such a space station, because of perfect conditions for photography and spectroscopy. It will also provide unique conditions for advanced research in physics, electronics, weather prediction, etc. Three such stations, properly placed, could blanket the entire world with nearly perfect TV transmission.

Atomic rocket vehicles with prefabricated skin layers (lower center) provide building materials for the station, then return (bottom) to earth. Similar craft will service an established station (lower right), docking by electromagnetic pull in lower section of station's axis.

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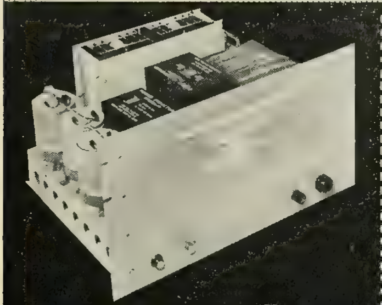
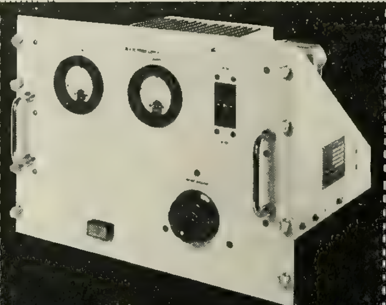


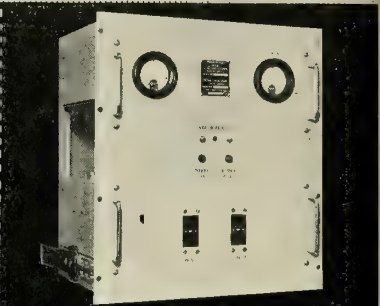
24-32 VOLTS @ 10 AMPS
MODEL NO. M990

Transistor—Mag amp power supply
DC Output: 24-32V @ 10 amps
AC Input: 105-125V, 1 phase, 60 cps.
Static Regulation: ±0.1% line & load
Dynamic Regulation: ±0.1% line; ±1% load
Ripple: 1 MV R.M.S. maximum
Output Impedance: 0.05 ohms, 0-20 KC
Protection: Short circuit proof; unit has automatic current limiting at 125% of rated load
Dimensions: 19"W x 10½"H x 15"D rack panel mount
Meets Spec. MIL-T-4860



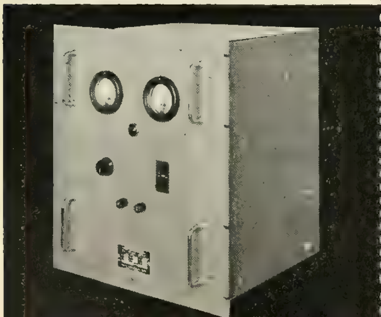
0-32 VOLTS @ 25 AMPS
MODEL NO. M1071

Mag-amp power supply
D.C. Output: 0-32V @ 25 amps (Surge loads to 35A for 30 min. or less)
A.C. Input: 115V, 1 phase, 60 cps.
Regulation: ±1% 28 volts—Not stabilized for A.C. line voltage changes.
Ripple: 1% RMS @ 32V and full load
Response Time: 0.1 to 0.2 seconds
Dimensions: 19"W x 14' H x 15"D Rack panel mount
Meets Spec. MIL-E-4158A



24-32 VOLTS @ 30 AMPS
MODEL NO. MTR28-30-2

Transistor—Mag amp power supply.
D.C. Output: 24-32V @ 30 amps
A.C. Input: 105-125V, 1 phase, 60 cps
Static Regulation: ±0.1% line and load
Dynamic Regulation: ±0.1% line ±1% for full load changes
Ripple: 7 MV RMS max.
Output Impedance: 0.05 ohms 0 to 20 KC
Protection: Short circuit proof; unit has automatic current limiting at 125% rated load
Dimensions: 19"W x 21¼"H x 14"D Rack panel mount
Meets Spec. MIL-E-4970

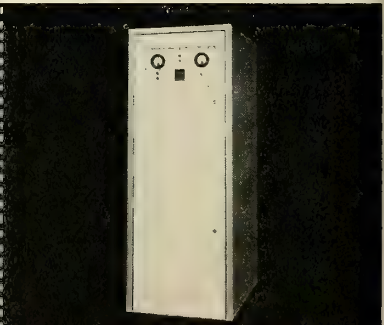


24-32 VOLTS @ 100A
MODEL M989

Mag-amp power supply
D.C. Output: 24-32V @ 100 amps
A.C. Input: 208/230 or 460V ±10% 3 phase, 60 cps
Regulation: ±½% for line & load
Ripple: 1% RMS
Response Time: 100 milliseconds
Dimensions: 19"W x 21"H x 16"D Rack panel mount
Unit incorporates remote sensing.
Meets Spec. MIL-E-4970

24-32 VOLTS @ 100A
MODEL M1136A

Transistor—Mag amp power supply.
D.C. Output: 24-32V @ 100 amps
A.C. Input: 208V ±10%, 3 phase, 60 cps.
Static Regulation: ±0.1% line, ±0.2% for load
Dynamic Regulation: ±0.5% line, ±2V. for full load changes
Ripple: 10 MV RMS max.
Dimensions: 19"W x 21"H x 18"D Rack panel mount
Meets Spec. MIL-E-4970



24-32 VOLTS @ 500 Amps
MODEL NO. M1134B

Transistor—Mag amp power supply
D.C. Output: 24-32V @ 500 amps
A.C. Input: 208/230/460 V ±10% 3 phase, 60 cps
Static Regulation: 0.1% line; 0.1% load
Dynamic Load Regulation: ±15% for full load changes
Ripple: ½% RMS max.
Response Time: Adjustable 20-200 MS
Dimensions: 26"W x 68"H x 32"D
Meets Spec. MIL-P-6457A

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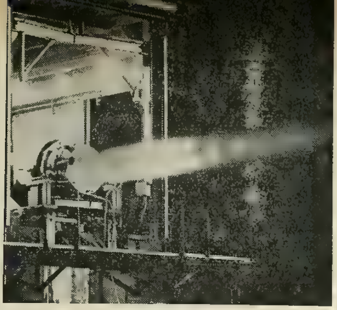

COVER: *In an evaluation captive test firing the United States' first throttleable-thrust rocket engine for the Air Force X-15 is put through its paces at Reaction Motors' Lake Denmark captive test facilities. Engine, which will be used to place the first man in space is now in final test (story page 24).*

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in this issue

DECEMBER 15 HEADINES

Satellites for Satellites
Soviets consider embarrassing West by helping other Red nations launch space vehicles 17

New Soviet Satellite tracked
September-launched *Sputnik* announced by m/r editor traced by stations in U.S. 17

Strange Battle of EIA and AIA
Struggle to establish wage rates makes strange bedfellows of unions and trade organizations 20

Air Force Faces Further Probe
House Committee indicates it will go further into R-W rate of profit-making 65

ASTRONAUTICS ENGINEERING

Discoverer has Recon Capability
New satellite test program will not include camera but will have this capability if needed 18

New X-15 Engine Tested
First throttleable rocket motor will go into first vehicle to place first man in space 24

MISSILE ELECTRONICS

New Thermal Switches
Westinghouse developes units whose resistance increases abruptly at specified temperature 27

JPL Radio Telescope
Army's Goldstone radio astronomy antenna modelled after University of Michigan Peach Mountain unit 37

NEW MISSILE PRODUCTS

Missile Automatic Checkout Unit
New universal automatic tester rapidly evaluates dynamic functional capabilities of weapon systems 54

Air-Cooled Beam Tubes
New units with ceramic-metal seals are capable of dissipating 250 watts at up to 500 mcs 54

DEPARTMENTS

Washington Countdown 13
Industry Countdown 15
Letters 47
Space Age 60
Keeping track 63
People 66
West Coast Industry 67
World Astronautics 68
When and Where 71
Contract Awards 72
Editorial 74

Environmental

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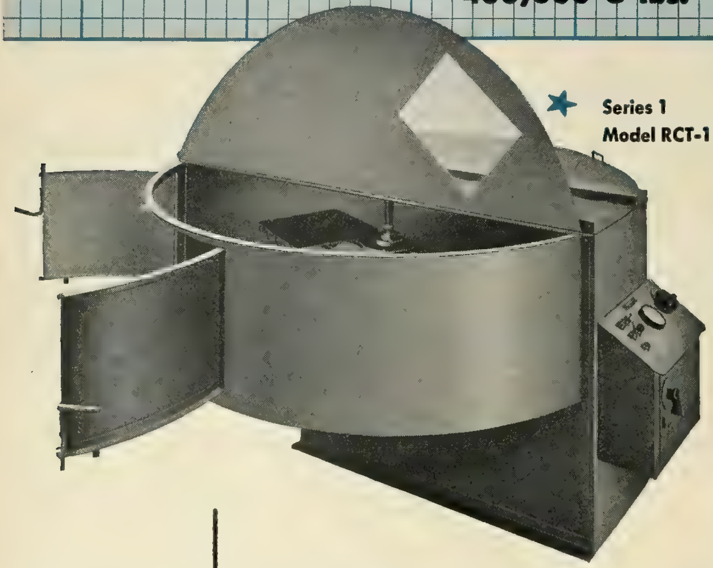

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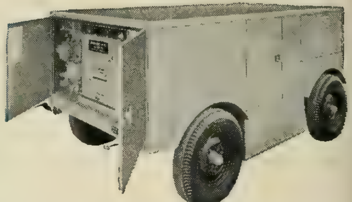

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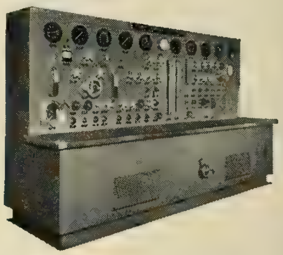

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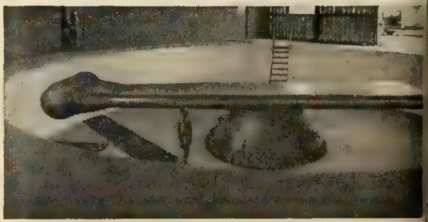

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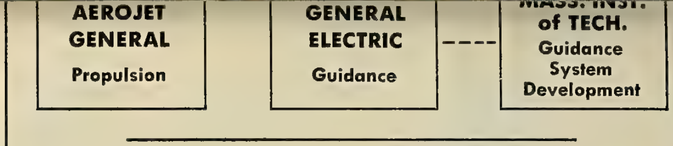
POLARIS MISSILE DESIGN & DEVELOPMENT TEAM

SPECIAL PROJECTS OFFICE
Bureau of Ordnance, U.S.Navy
Weapon System Manager



Also working under the direction of the Special Projects Office, U.S. Navy, on various phases of the POLARIS weapon system are: U.S. NAVY BUREAU OF SHIPS, SPERRY GYROSCOPE CO., WESTINGHOUSE, and over 200 sub-contractors—a team composed of America's topmost scientific talent with vast technological resources, working together on one of the Navy's top-priority defense projects.

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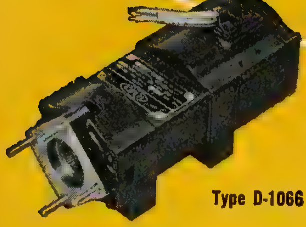

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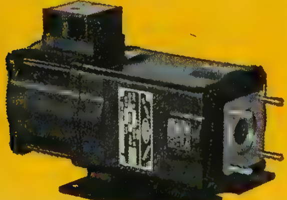
For supersonic aircraft applications. .71 HP DC motor, 7600 rpm continuous duty, 24 volt. For pump drive. Weight: 6.5 lbs. Meets MIL-SPEC M-8609.



Type D-1086

For missile applications. 9 HP DC motor, 12,000 rpm intermittent duty, 56 volt, explosion proof. Weight: 14.75 lbs. Meets MIL-SPEC M-8609.

Type D-978

For missile applications. Tested successfully at over 200,000 ft. altitude, this ⅓ HP, 27 volt DC motor (ranges 24 to 32 volts) delivers 12,000 rpm, weighs 2.75 lbs, has radio noise filter, is explosion proof. Built for high shock and vibration loading. Meets MIL-SPEC M-8609.

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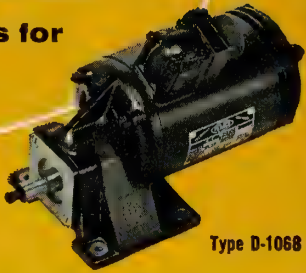
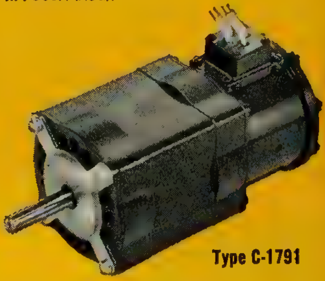


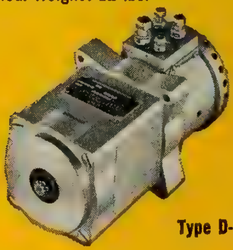
Type D-1068

For missile applications. 2.75 HP AC motor, 3140 rpm at gear box, continuous duty, 200 volt, 400 cycle, 3 phase. Power factor: 83%. Overall efficiency: 76%. Weight: 11.25 lbs. Meets MIL-SPEC M-7969A (ASG).



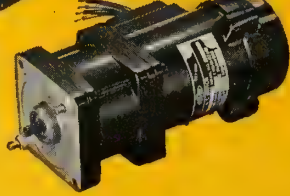
Type C-1791

For ultracentrifuge application. 1½ HP AC motor, 12,000 rpm continuous duty, 115 volt, 60 cycle, single phase, fan cooled. Weight: 12 lbs.



Type D-1025

For motor truck turbine engine applications. Starter-generator, weight 14.5 lbs. As starter: breakaway torque 220 in-lbs, terminal voltage of 20 volts. As generator: 40 amps continuously with intermittent peaks up to 80 amps at 28 volts.



Type C-1874

For actuator applications. 400 cycle, 3 phase AC motor and clutch. Intermittent duty, 12,000 rpm on 200 volts, 650 watts output. Weight: 4.5 lbs. Meets MIL-SPEC M-7969A (ASG).

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washington countdown

No air-launched IRBM . . .

program has been approved, according to DOD's missile office. However, other sources indicate that Martin, Lockheed and Convair are busy on WS-199B, of which one version is called *Bold Orion.*

The *Eagle* concept . . .

represents a new trend because the launching aircraft may be relatively slow since high performance is built into the missile, according to Rear Adm. Robert Dixon, in announcing award of the air-to-air missile design competition. Bendix Aviation Corp. will have prime weapon system responsibility and Grumman will provide the frame. Nine firms entered the competition.

First *Polaris* squadron . . .

designed by the Navy will be Squadron 14. It will consist of two divisions for a total of eight to 12 boats. The first boat, the George Washington, is to be launched next spring at Electric Boat's Groton yard. Others will be the Patrick Henry, the Theodore Roosevelt, the Robert E. Lee and the Abraham Lincoln. Meanwhile, *Polaris* is on schedule, according to Rear Adm. W. F. Raborn, and the Navy has commissioned the USS Observation Island. It incorporates the first shipboard launcher for *Polaris,* plus equipment to test the control systems. Submarine launches will be made next summer.

Faith in the *Titan* . . .

was reaffirmed by BMD's Maj. Gen. Bernard Schriever at an AMF meeting in New York. Although behind *Atlas* by perhaps 18 months, *Titan* will have the advantage of the underground sites (which AMF is building). Later Schriever inspected this work at AMF's Greenwich, Conn., plant.

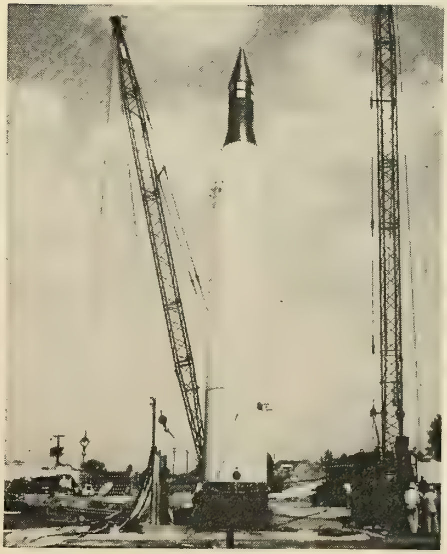
Classes in space technology . . .

will be held to educate the House Space Committee into the mysteries of the Space Age. Lecturers will be military, government agency and scientific technicians in every segment of the missile field.

Second *Juno* Due in February

For the lack of three seconds burning time and a firing angle error, *Juno II,* shown at right on its checkout pad, failed to reach or pass the moon in the NASA-Army try December 6. Maximum altitude was 63,000-plus miles, about 175,000 miles short. Next try probably will be in February.

Exact cause of the failure was faulty valve adjustment resulting in improper fuel mixture and short burning by 3.7 seconds, plus an aiming error of about three degrees low. Result: *Juno* reached only about 24,000 mph instead of the planned 24,995. In mitigation of her failure, *Juno's* payload (*Pioneer III*) provided high priority information on radiation. *Juno's* 60-plus tons (fueled) consisted of an elongated *Jupiter* first stage; 11 clustered *Sergeants* in the second; three in the third, and one in the fourth. The gold-plated conical payload weighed 12.95 pounds.



Something to see...

for the pilot who's flying blind

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A DIVISION OF NORTH AMERICAN AVIATION, INC. · Downey, California **Autonetics**

industry countdown

RAT project . . .

has reportedly been terminated by the Navy, replacing the rocket assisted torpedo with the *ASROC* (anti-submarine rocket) weapon. *ASROC* is an atomic-warhead equipped missile produced by Minneapolis-Honeywell. M-H now produces atomic warheads for eight missiles: *Honest John, Little John, Lacrosse, Talos, Tartar, Terrier, Corporal* and *ASROC*. The Sandia Corporation has systems control on nuclear warheads, with M-H handling production.

Jupiter and *Thor* . . .

missiles, which have become "less interesting" with the development of ICBMs demonstrating encouraging strides, are expected to continue in production for at least another year. Army commitments for the *Jupiter* total $185 million while contract figures for the *Thor* are still on the secret list. U.S. is committed to supply 60 *Thors* to Britain and probably about 45 *Jupiters* to Italy. Deliveries of these missiles to France and Turkey—if and when—are expected to come from current production.

Future of IRBMs . . .

is likely to be extremely limited. Increased demands for the missiles from the NATO nations will probably not materialize, with Britain and France developing their own IRBMs. Except for space projects and training purposes, for which a few will probably be stockpiled, *Jupiter* and *Thor* will fade out of the weapon systems arsenal within two years. Even in the role of space vehicles, their utility will be limited by the rate of development and stockpiling of the ICBMs slated for this usage by 1960.

Goose decoy missile . . .

is another weapon with an uncertain future. This missile, designed to divert enemy air defenses during an attack by SAC bombers and missiles, is now being reviewed to determine whether the development of the weapon will continue. The Air Force has suspended construction of launching facilities for the intercontinental missile at Ethan AFB in Vermont and at the Duluth airport in Minn. The *Goose*, a surface-to-surface missile developed by Fairchild, could be replaced by the McDonnell *Green Quail*, an air-launched decoy designed for launch from SAC bombers.

Bomarc base construction . . .

will be on the upswing for 1959 with one site well underway, contracts let on three and 10 planned with no contracts let. An estimated 50 sites will be dispersed through-out the United States if program is fully realized. Each site with 56 launching positions costs $13.5 million.

Minuteman motor production . . .

may have to be carried out in newly constructed facilities. Air Force Secretary Dudley Sharp said that the size and weight of the solid propellant grain for the *Minuteman* is beyond the capability of current solid facilities. Sharp added however, that components for the missile will be mainly produced in existing plants.

New *Minuteman* facilities . . .

could result in "great waste," according to a statement by Rep. Robert A. Everett (D-Tenn) before the House Military Investigating Subcommittee. Everett said the Air Force should look into the possibility of using Army arsenals to load the *Minuteman* and other solid propellant missiles. Sharp emphasized there was no prohibition against using the facilities of a sister service when they fill requirements and explained that the Air Force program was "aimed at obtaining an industrial base which is adjusted to firm weapon program needs, and is privately capitalized to the maximum degree."

Mobile handling equipment . . .

for the new generation of solid propellant missiles is under development by the Hufford Corp. with a $225,000 subcontract from Thiokol Chemical Corp. The mobile rocket motor handling device, known as a "Transrector" will have a capacity for handling missile units up to 35 feet long, 85 inches in diameter and weighing 80,000 pounds.

Future Project *Rover* tests . . .

may be run on duct-type test stand in order to solve the problem of radiation and combustion of the heated hydrogen with the surrounding atmosphere after it has been discharged from the nozzle—phenomena that is common in testing the nuclear rocket. The test facility would hold the engine in a vertical position with exhaust gases carried through a water-cooled aluminum duct away from the nozzle.

50,000 rocket engine tests . . .

is the record for Rocketdyne's propulsion field laboratory since it began operations ten years ago.

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DECEMBER 15, 1958—VOL. 4, NO. 24

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

USSR Plan: *Sputniki* for Sputniki

by Alfred J. Zaehringer

WASHINGTON—Having already reaped benefits by establishing the first earth satellite, the Soviet Union is expected to assist her own satellite nations in establishing orbiting satellites of their own, m/r has learned.

Directly designed to embarrass the West, orbiting satellites are expected to give tremendous prestige to such nations as East Germany, Poland, Czechoslovakia, and Red China.

Not only would the new satellites place these countries—in the eyes of the "neutrals"—on a par with the U.S., but they would orbit them ahead of Britain and France. These satellites can be expected as early as mid-1959. In addition, the large Soviet stockpile of missiles would enable these countries to orbit substantially larger satellites than the *Vanguard* or *Explorer*. Payload capabilities are expected to be on the order of 50-100 lb.

- ***T-1* would be used**—First stage rocket for such a satellite system would probably be the now obsolete *T-1* missile. It resembles the U.S. *Redstone* and has a higher thrust capability than its early 78,000 lb LOX-jet fuel engine. Second stage would be a lash-up of from three to five *T-5*, *T-6*, or *T-7A* solid propellant artillery rockets.

Last stage would consist of a single solid propellant engine (probably the same as the second stage type), plus a total satellite package of around 45 kg (about 100 pounds). All solid stages would probably have to require considerable weight saving to effect good mass ratios. Possibly higher propellant performance also would be required.

If the total satellite weight could be kept to 50 pounds, then the total vehicle weight at launch would approximate 100,000 pounds—indicating marginal performance for the standard *T-1* engine. More probably the *T-2* 220,000 lb thrust LOX-hydrocarbon engine would have to be used. However, if a satellite of about 25 pounds can be tolerated, then the standard *T-1* engine could be employed with thrust up-grading.

It is possible, however, that by weight saving and the use of high energy propellants, a satellite of about 100 pounds can be orbited by use of a lash-up vehicle. It is more than likely, therefore, that 2000:1 (vehicle weight to satellite weight) would be the Soviet technique rather than the 1000:1 ultra-performance technique. The launching vehicle with a height of about 110-feet would have a long "bean-pole" effect because the Soviets would rather throw considerable thrust into a launch than employ a complexity of stabilization techniques.

- ***T-1* to be used for training**—The Soviet *T-1* missile (range on the order of several hundred miles) is now obsolete and will be used for training and test vehicle purposes. The solid upper stages are becoming increasingly available due to shelf life characteristics.

This means the USSR will have several hundred potential satellite capabilities within the next 1-5 years. It is indeed possible that such a satellite has already been tested. The Soviets would be extremely reluctant to release information about such a satellite: 1) because of its small weight, 2) because it would be in a crude-relatively unstable orbit, and 3) because it would yield data directly applicable to the military IRBM and ICBM program. Many satellites, for example, would be needed to get data concerning the upper atmosphere (100-500 miles) on a statistical basis.

Use of East European launching sites would establish a north-south or polar orbit. Use of sites in Red China would be attractive for utilizing some of the earth's equatorial velocity. China may launch a satellite sometime in 1959, and the home of the rocket, will again shine in national glory.

Total Satellite Wt., Lb.	Total Vehicle Wt., Lb.	First Stage Thrust, Lb.	Notes
25	50,000	78,000	Standard *T-1* Engine
50	100,000	220,000	Standard *T-2* Engine
50	75,000	80,000	Up Graded *T-1* Engine
50	50,000	80,000	Up Graded *T-1* Engine plus Better Mass Ratio
100	100,000	220,000	*T-2* Engine plus Better Mass Ratio

'Runaway' Sputnik tracked past moon

WASHINGTON—m/r Editor Erik Bergaust, revealed recently that a Russian vehicle had been tracked to the vicinity of the moon and beyond.

Since Bergaust's disclosure, reports from tracking installations in the United States and England have corroborated the announcement although there has been no official confirmation.

The Russian space probe attempt, launched on/about September 24, is generally believed to be a lunar probe that failed to orbit.

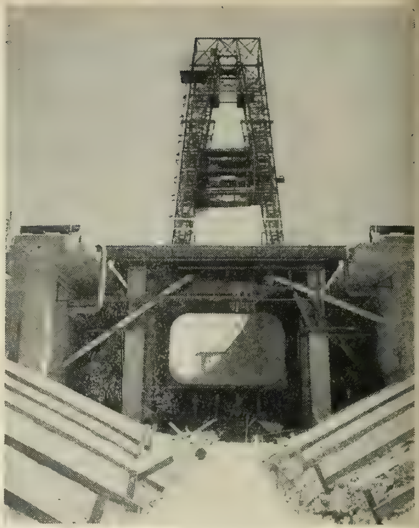
The Soviet space venture has apparently been tracked not only by radio—at 40.007 mcs and 20.003 mcs—but also by radio telescope. A capsule summary of the tracking reports in chronological order follows:

1) A report, supposedly originating from various intelligence sources, refers to three separate tracks made since the launching of *Sputnik* III. Objects were tracked by the ionized gases produced by the exhaust paths through space. One was tracked for a distance of 10,000 miles—another to the vicinity of the moon and beyond.

2) Radio signals were received on 40.007 mcs at Cape Canaveral for three hours.

3) Radio signals were intercepted by Lockheed's Missile Tracking Station on 20.003 mcs on November 26. Absence of the doppler effect indicated travel away from earth.

Thor **PAD has been completed at Vandenberg AFB, for first** *Discoverer* **shot into space.**



BEFORE 1960, 5-ton satellites will leave *Atlas* **pads at Southern California base.**

Discoverer Has Recon Capability if Needed

by Norman L. Baker

WASHINGTON—First vehicle of the Air Force's Project *Discoverer*, once the WS-117L satellite program, was being readied for launch as m/r went to press. Although the aims and intent of the program have been drastically "changed" (m/r, Dec. 8, p. 21), the satellites have been designed to eventually provide the United States with a world-wide surveillance capability, if and when we feel justified in sending them aloft.

The top-level policy switch will involve only a slight alteration of payload instrumentation—specifically the elimination of the camera. Basic booster vehicle and satellite design will remain essentially the same.

New designation of *Discoverer* for the Air Force satellite program was announced by ARPA's Roy Johnson, who said it is "the largest single item" in the agency's 1959 budget. The main purpose of the program is to develop "useful information" for putting a manned vehicle into orbit around the earth by first putting animals into orbit and returning them safely to earth. Animals being prepared include mice and monkeys. They probably will not go aloft, Johnson says, until the fifth or sixth launching. No attempt will be made to put man in orbit during 1959, Johnson adds.

Earlier names for the WS-117L project were *Big Brother*, *Pied Piper*, and *Sentry*. Later the project had the unofficial title of *Baby Sentry*.

Discoverer test vehicles will be sent aloft from a recently completed pad at Vandenberg AFB (m/r, Dec. 8, p. 21) in the nose of a two stage rocket. Original plans called for *Thor* as booster with an extremely high total impulse solid propellant second stage. Current program will use a modified *Pioneer* system, a *Thor* first stage with a high energy Bell Aircraft liquid second. The basic *Pioneer* system has a capability (with optimum performance) of orbiting up to 400 lbs. Added thrust, supplied by the Bell rocket, will also place the second stage in orbit boosting total satellite weight to 1300 pounds.

First nine shots probably will be boosted into orbit with the *Thor* configuration while awaiting the availability of the *Atlas*. The *Atlas* is expected to reach a sufficient level of reliability before the end of next year, Johnson said.

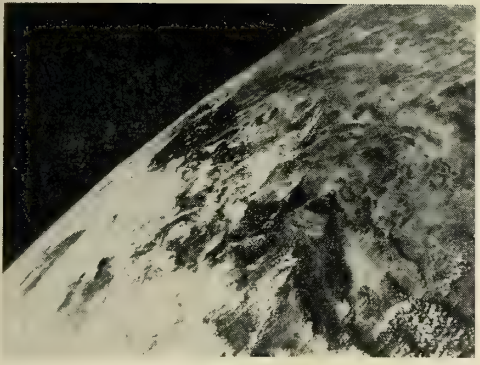
• **Boosters**—*Atlas* C or D eventually will be used for the first stage booster with a Bell Aircraft high energy liquid propellant second stage, reportedly using the high impulse fluorine. Twelve of the *Atlas* configurations, having a 10,000-lb. total satellite capability, have been planned for the advanced program. Any hopes for utilizing the *Atlas* before then are diminished by the current limited financial support and minor technical difficulties encountered throughout the system.

The instrumentated packages scheduled to be launched with the *Thor* vehicles will be low orbiting short-life packages. Launch will be due south passing over the polar regions and the entire earth's surface in about five orbits, or eight hours. First satellites will make only about two complete passes over the entire earth's surface (about 10 orbits) before burning in the upper regions of the atmosphere.

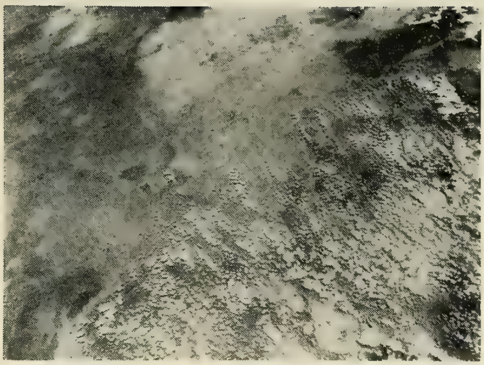
The program is being initiated without waiting for the completion of eight additional tracking stations needed for the large satellites scheduled for the program next year. Initial tracking will be handled by a ship stationed down-range from Vandenberg and stations in Hawaii and Alaska. The station in Alaska is expected to be capable of monitoring the satellites during each orbit. A near circular orbit ranging in altitude from 175 to 200 miles will be attempted.

When the series graduate into a reconnaissance project, the position of the orbit is of considerable importance. This establishes the attitude of observation, the amount of the earth's surface covered at each pass, and the time of appearance of a certain region, according to a report on satellite recon studies by the DuMont Laboratories.

• **Scanning capabilities**—The vision area from the satellite is very great even from minimum altitude orbits. For example, at the altitudes programmed for the first test satellites, the vision area would extend almost completely across the United States.



FUTURE RECON satellites will make large scanning sweeps of a large section of the earth's surface.



VIEW FROM orbit will be similar to this 158-mile shot taken from a *Viking* research rocket.

Vision angle would be about 145 degrees and vision arc would extend approximately 2400 miles with 15% of the earth's surface falling within the cone of observation.

In any reconnaissance orbit, not all of the observed area will be useful since the line-of-sight is near grazing incidence at maximum distances from the satellite. If 45 degrees is considered to be the minimum useful vision angle, the useful coverage is reduced to about 1/3 in distance and about 1/9 in area. Distortion errors induced by the curvature of the earth and the refraction of the atmosphere will reduce the vision angles considerably when earth surface position determination is of prime importance.

• **Test investigations**—Initial tests must be made to determine the perturbations in the orbit caused by error in launching, oblateness of the earth, atmospheric drag, and possibly the gravity field of other heavenly bodies. Orientation of the payload package in orbit in order that the optical system is always pointed toward the center of the earth will, of necessity, be a major field of investigation.

Orientation of the satellite may be accomplished by circuiting an electromagnet with a stable platform. The electromagnet would always point toward the center of the earth. Sensors would detect any change in attitude of the satellite, transmitting the variation to a servo-system tied to a gyro stable platform. This was the system used for the orientation of *Sputnik* III, a satellite designed for controlled orientation in space.

Payload weight limitations for the first shots would severely limit the number of data pickup instruments and the associated equipment necessary for processing, storage, and transmission of acquired data.

Later, more advanced satellites may be able to transmit many different types of information to the command stations, including such data, as pressure, temperature, radiation and television pictures.

• **Data storage**—As long as a recon satellite program involves the launching and operation of only one satellite at a time, long-term storage becomes almost mandatory, since the recording and transmitting functions must be accomplished on opposite sides of the globe. Two methods of data storage are available: magnetic tape or wire recording, and film recording.

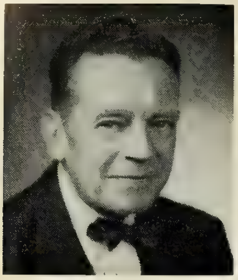
At least one satellite in the Lockheed program, as stipulated in the original project, was designed for infrared detection capabilities. This type of detection is highly desirable for the interval of the satellite's orbit when the earth's surface is not in the sun's illumination. Under these conditions the only radiant energy available to the detector is the self-emission from the earth.

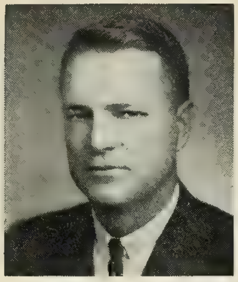
• **Missile detection**—An outstanding application for reconnaissance from a satellite is the detection of missile firings, especially of the ICBM size. The main difficulty arises from the fact that for reliable detection within the short burning time of the rocket an extremely large area must be surveyed. This is in contrast to the mapping technique where the earth's surface is examined point-by-point in time sequence using a very narrow elemental field of view. Photomultiplier detectors would be used for increasing the contrast by comparing the ICBM firing signal with the general background illumination.

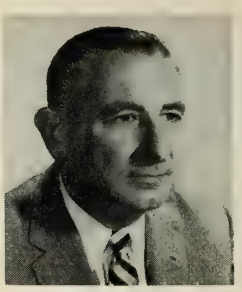
Infra-red detectors, incorporated within the instrument package, would further increase the contrast of the missile against the earth surface background and allow detection of smaller missiles of the IRBM class.

• **Maximum coverage**—At 200-400 miles altitude, at least eight satellites would be needed to cover instantaneously the periphery of the observation orbit. Launched at intervals of about 20 minutes, as many as 24 satellites would be needed to cover the entire earth's surface at any instant. By precise timing this number could be reduced considerably and still have continuous transmitted data from "enemy" territory.

• **Contractors** — The test vehicle series is almost exclusively a Lockheed Missile Systems Division product. The more advanced versions scheduled for late 1959 and 1960 will incorporate highly sophisticated systems developed by the following contractors: Engineered Magnetics Co., transducers and converters; Telechrome, telemetry transmitters; Lockheed, satellite frame; Mallory, rechargeable batteries (recharged by solar cells); Remington-Rand, Univac computer system; Philco, receivers and associated tracking equipment; Ampex, magnetic tape recording system; and Sperry-Gyro, orientation gyro system and Eastman Kodak for future camera systems.


David R. Hull


William L. Reynolds


Joseph H. Baylis

Robert Canan

Wage Battle Could Mean $1 Billion Cost

by Raymond M. Nolan

WASHINGTON—A wage-labor battle now in progress in Washington has many of the basic elements of good musical comedy. Unions involved have joined with traditional enemies to argue one side. Some of the contestants belong to each of the two trade organizations joined in the struggle.

The point of contention is the Walsh-Healy definition of the aircraft industry. The protagonists are Aircraft Industries Association, the United Automobile Workers and the International Association of Machinists on one side, and the Electronics Industries Association on the other.

• **Wage structure issue . . .** The basic problem is this: Under the terms of the 1937 Walsh-Healy act, all firms which bid for one particular phase of government business must incorporate the same wage structure so that unfair competition will not exist. The determination of a fair wage is the responsibility of the Labor Department's Wage and Hour and Public Contracts Division.

Under the Walsh-Healy act, if several manufacturers are bidding to furnish items to the government, then each of these must pay substantially the same wage rates.

This rule has operated with a minimum of trouble for years. However, demands of the space age and the rising dependence on electronics within the aircraft industry have presented new problems.

• **$1 Billion Issue . . .** At stake are these vital points: If the Unions and aircraft industry win the battle, $1 bilion will be added to our defense bill, EIA estimates, and many electrical appliances would take a six or eight percent jump in price.

If AIA and the unions lose, the aircraft industry is faced with the most serious, industry-wide labor troubles in its history.

The situation is not new; it has been some time in the making. The last definition of the aircraft industry was made by the Department of Labor in 1950. This definition excluded electronics as such and did not consider missiles. However, for the proposed redetermination, AIA feels that any electronics equipment peculiar to the particular airframes is properly part of that airframe and should be considered part of the aircraft manufacturing industry.

This is also the case with missiles. AIA quotes statistics to show that a majority of the missile systems in existence are administered by airframe manufacturers.

There has been a trend for the past few years for airframe manufacturers to establish separate missile and electronics divisions. Some of these are Northrop's Nortronics, Convair's Astronautics, Lockheed's Sunnyvale and North American's Autonetics. When the airframe manufacturers established these divisions, they continued to pay the wage rate determined for aircraft. These rates are approximately 50 cents an hour greater than the prevailing rates in the electronics industry. Herein lies the rub.

Statement of the problem is simple enough: Shall the aircraft industry continue to pay aircraft wage rates to missile and electronics workers?

Shall they adjust these rates to those of the electronics industry?

If the former course is taken, then the electronics industry would be forced to raise wages in order to comply with Walsh-Healy provisions. If either of the latter, it is not difficult to foresee some of the violent labor eruptions which would face the aircraft industry.

Unfortunately, as is common in most broad problems such as this, each side has a good case and each can predict dire results if the decision goes against his interests.

• **EIA's case . . .** EIA waded into the battle after President David R. Hull polled his board of directors on June 23 of this year to determine the policy EIA should follow. The unopposed decision was that EIA should lodge strong objections to any extension of the aircraft wage rates to missile production and the electronics industry and also to any automatic identification of missile production sources as being identical to those of aircraft.

This view, of course, is directly opposite that of AIA. And it is also opposite to that of the UAW/IAM who see in the fight an opportunity for an extension of the relatively high aircraft wage structure into many places where these wages do not now exist.

One interesting facet of the controversy is that many AIA members such as Sperry-Rand, Westinghouse, Minneapolis-Honeywell are also members of EIA. Their views are certain to oppose some of the arguments put forth by either opponent.

The EIA contention is that there is a separate electronics industry and separate missile production sources which are not necessarily identified with the aircraft industry. In comments filed before the Department of Labor on October 31 by William L. Reynolds, general counsel of EIA, two conclusions are put forth:

1) Missile production in itself is not a distinct industry but a combination of products of different industries;

2) At this stage of its development missile manufacturing cannot be catalogued either as a unique industry in itself or as a subdivision of any industry—much less the aircraft industry.

EIA then, touches on its most important point—one which does not necessarily affect all of the missile producers—but does have far-reaching effect on the entire U.S. economy.

This point is that there is no segregation in electronics plants between workers engaged in defense work and those producing consumer equipment. How could you separate a group of employees covered by the same bargaining unit into higher pay-sections for defense work and lower pay-sections for non-defense work? And in the manufacture of sub-assemblies and components, common to both defense and consumer end products, how do you determine a fair price?

One alternative, if the definition should be broadened to include electronics, would be to raise wages throughout the electronics industry. But, as EIA points out, consumer products such as washing machines, television sets and radios produced by workers making some 50 cents an hour more would cost more money.

Actual figures for both wage rate were quoted in the most recent bulletin of the Bureau of Labor Statistics on "Employment and Earnings" (Vol. 5, No. 3, Sept. 1958) which showed that average hourly wages in the aircraft industry were $2.53 during July, the last month for which published figures are available. In contrast, the corresponding wage rate in the electronics industry was $2.07, a difference of forty-six cents, or an aircraft wage rate 22 per cent higher than the electronics rate.

• **Greater budget . . .** For missiles, the argument advanced by EIA is that the increased cost would be in missile production and reflected upward into a greater defense budget.

Reynolds says, "Both the President and DOD have been increasingly concerned with the mounting costs of the new weaponry essential to maintain the position of our nation in the cold war. Because of the great disparity in wage levels between the aircraft industry and the electronics industry, it is clear that any determination which would place a segment of the latter industry in the aircraft classification would vastly increase the labor costs of missile development.

". . . electronic equipment is by far the most expensive item in the production of a finished missile. As the actual cost of the materials in such equipment is comparatively small, a heavy proportion of the cost—perhaps as high as 90 per cent because of the large number of hand operations—is charged to labor. Thus an aircraft determination applicable to missile electronics equipment might well mean an added cost in the neighborhood of 20 percent to the government . . ." Reynolds estimates that the determination could add an annual $1 billion to the budget.

Considering another aspect, Reynolds says that there is a real danger that missile development itself would be retarded. Since missile and consumer products are produced in the same plants and the consumer market in electronics is so fiercely competitive, many companies now participating in missile development would hesitate to continue if faced with a wage scale which would affect the price of everything produced in their plants.

Since the decision of EIA's board to oppose the new definition, two panel meetings have been held at the Labor Department and two briefs filed, October 31 and November 17. Next brief is to be filed in December.

• **AIA's case . . .** Key to AIA's case is the proposed redefinition wherein the 1950 definition is expanded to embrace "manufacturing (including assembling) . . . guided missiles; . . . guided missile propulsion systems; . . . guided missile airframes; . . . and parts and accessories especially designed for use with or on these products; . . . fuel systems, armament and equipment . . ., and specialized . . . guided missile servicing equipment.

AIA cites as precedent other industries such as the iron and steel and the paint, varnish and related products industries where redeterminations to add new classifications were accomplished.

The complete argument by AIA is best stated by quoting from Page 4 of its brief: "The basic elements of the first airplane were the structure, the power plant and the guidance and control systems. The same major elements are present today in both manned and unmanned vehicles, and they will be the basic ingredients of tomorrow's airborne vehicles, manned or unmanned. Despite the revolutionary changes in product performance, the end-product —a guided flying vehicle has remained the same.

"The proportion of effort devoted to each of the basic elements in the airborne vehicle (aircraft, controls, guidance and power plant) has changed from time to time. Today, for example, the control and guidance systems are assuming more and more importance; and as new altitude and speed ranges are achieved, it will be necessary to develop and perfect new propulsion systems. Another far-reaching trend is toward specialization of airborne vehicles and all their elements, to an extent unknown a decade ago.

"Notwithstanding such changes in emphasis, the basic elements of the airborne vehicle remain unchanged; and all are integral, inseparable products of the industry. The burden is surely upon anyone who takes a contrary position to prove otherwise, and no such proof has been adduced."

AIA's spokesmen, led by Robert Canan of Lockheed and Joseph Baylis of Fairchild, contend that they are not concerned with components as such, since items such as transistors, tubes and servo motors are customarily manufactured outside the aircraft industry.

The systems which AIA proposes be included in the redefinition are those especially designed for and having special functions in particular guided missiles and other airborne vehicles.

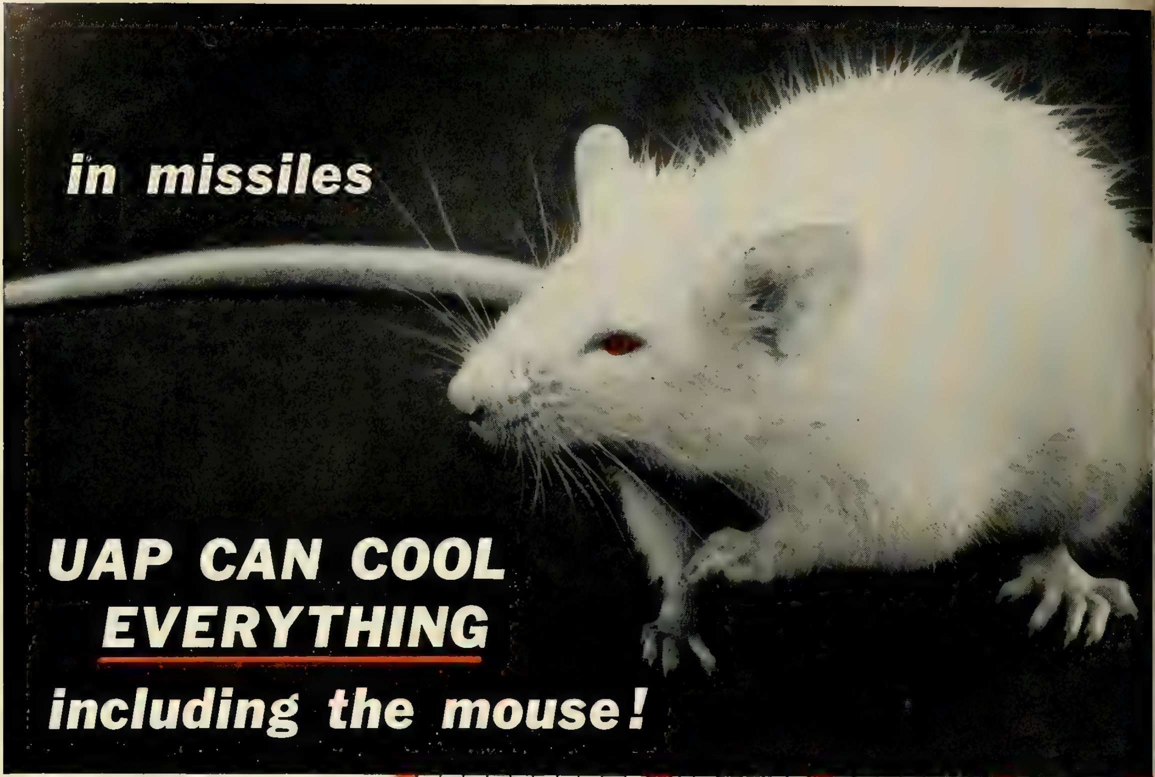
Each system, according to AIA, embodies a complex subassembly of many units of equipment and their components—not electronic alone, but an appropriate combination of electrical, electronic, mechanical, hydraulic and pneumatic elements—having the relationship to the entire system which the human brain, nervous, sensory and motor systems have to the entire human organism.

AIA is concerned here with what amounts to a de facto situation—divisions of almost every major airframe manufacturer are now building electronic systems and paying aircraft industry wage rates. None of these manufacturers intend to get out of the electronics or missile business and none of them intend to meet the labor force head-on in a wage cutting situation. So, while AIA limits its arguments to the "proper" definitions for systems and for prime contractor, they obviously do not feel that any other points must be developed to win the argument.

In the definition of prime contractor, there is some disparity between the views of EIA and AIA. EIA rightfully states that first tier sub-contractors are predominantly electronics manufacturers, but does not make too strong a case for their contention that this waters down the definition of prime.

So the situation remains awaiting a decision by the Department of Labor, personified by Harry Weiss, assistant administrator for the Wage and Hour and Public Contracts division.

The outcome is squarely dependent on the Department of Labor and in the words of one AIA spokesman, "this situation needs the judgment of a Solomon."



		missile type										service use						propulsion							guidance					ground support
		Surface-Surface	Air-Surface	Air-Air	Surface-Air	ICBM	IRBM	IGBM	Drone	Tactical	Unknown	Army Ordnance	USAF	NAVY	Army Sig. Corps	Bur. Aeronautics	Unknown	Liq. Fuel Rocket	Solid Fuel Rocket	Booster	Ram Jet	Turbo Prop	Gas Turbine	Unknown	Radar	Inertial	Infra Red	Radio	Unknown	
cooling systems	Mechanical Refrigeration				■	■							■	■						■	■				■			■		
	Expendable Refrigeration	■			■	■							■											■					■	
	Cryogenic					■							■			■		■									■			■
	Heat Transport								■			■	■											■					■	■
	Console Cooling	■		■	■		■			■		■	■			■		■	■						■	■				
	Evaporative	■			■				■				■									■						■		
heat exchangers	Liquid/Air	■	■		■				■				■		■			■		■	■				■	■		■		
	Ammonia/Glycol	■											■											■					■	
	Liquid/Gas										■						■				■								■	
	Evaporative		■										■											■					■	
	Liquid/Liquid	■	■		■								■	■						■			■			■				■
	Liquid Ammonia/Liq. Oxygen					■							■					■							■					
	Hot Gas/Nitrogen Tetroxide				■									■										■					■	
	Ammonia/Air				■								■								■				■					
	Cold Plate	■		■										■		■			■						■	■				
valves	Rupture		■		■									■				■							■					
	Explosive				■									■										■					■	
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	Bypass			■	■	■			■				■									■						■		■
	Temperature Control										■						■							■					■	
	Pressure Control										■						■							■					■	
	Solenoid		■		■								■								■	■				■		■		
	Thermostatic										■						■							■					■	
hand pumps																														■
oil tanks	All-Attitude	■	■	■	■			■	■				■	■	■			■				■						■		

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Propellant Gases Used for Auxiliary Power

by Alfred J. Zaehringer

DETROIT, MICH.—Vickers, Inc. has successfully employed the hot gases obtained directly from combustion of solid and liquid propellants to drive a positive displacement fluid power motor. The new system uses proven hydraulic components to give an integral package.

Auxiliary power, often called secondary power, is non-propulsive and is used to drive the myriad of pumps, controls, generators, and other equipment that are used on missile and rocket systems. A complicating factor has been that of a completely self-contained power source. Requirements for AP systems are on a steady increase.

Solid propellants show advantage for power levels under 10 horsepower and operating times of several minutes or less. Solids are storable and show high energy content per volume of weight, and are simple.

Much of Vickers development work has been with double base solids. Such homogeneous propellants have relatively clean and stable burning characteristics. However, the big problem has been with the inhibitor used in the end burning charges. These inhibitors decompose and give a carbonaceous residue.

Initially the residue was filtered out but it tended to clog the filter. Running with the residue showed that it caused no difficulty in the running. Gas motors used in experiments have been hydraulic motors with a minimum of re-work—the major change being the valve plate material. Even the hot gas motor is a standard Vickers piston-type hydraulic motor with minor modification. It is Vickers' opinion that the positive displacement motor is superior in many applications to a turbine for the following reasons:

1) Rotational speed closely matches that of either hydraulic pumps or electrical generators.

2) The gear box is eliminated.

3) The motor case is filled with hydraulic fluid assuring good lubrication for bearings, pistons and cylinder blocks, and serves as a heat sink to dissipate heat absorbed from the hot gas by the working parts.

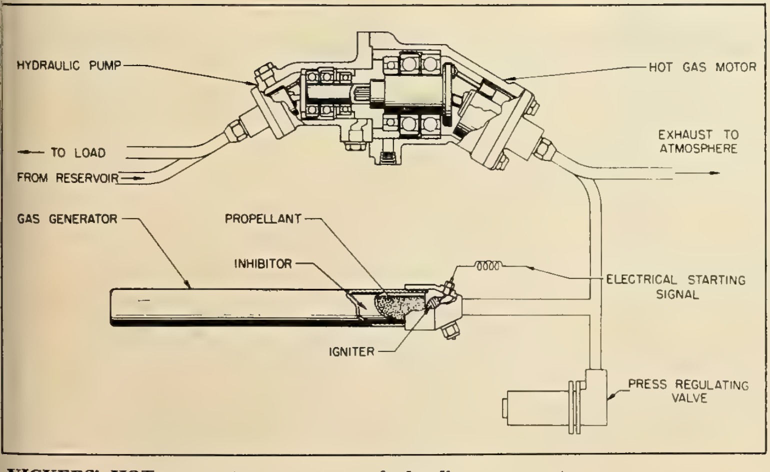
• **More efficient**—Vickers also believes the positive displacement motor is more efficient than the turbine—especially at off-design points. Higher efficiencies are directly translated into lower fuel consumption and overall system weight.

Full admission motors (gas admitted during the entire downstroke of the piston) appear to be promising for short operating times—of 10 to 20 seconds. For longer operating times where fuel economy is required—the partial admission motor (gas admitted during the initial portion of the downstroke only) looks promising.

For longer operating times, Vickers has investigated using the liquid propellants carried aboard the missile for thrust production. One test has used hydrogen and oxygen burning at about 5200 F. It ran for 39 seconds and halted because of rupture of a stainless steel line connecting the combustion chamber and the motor inlet.

A hazardous test area has been erected and placed into operation for development of solid and liquid auxiliary power units. Other power sources are also being evaluated. Battery power to drive an electric motor which in turn drives a hydraulic pump, and energy stored in a flywheel are some of the other auxiliary power sources of interest to Vickers. Studies show, for example, that for extremely short time durations, a flywheel offers extremely high energy storage capacity per unit of space and weight.

The Vickers safety test facility is a self-contained laboratory separated from the main engineering center in Detroit. Six steel-reinforced concrete test cells permit safe handling of hazardous tests. Closed circuit TV permits monitoring all tests with complete safety to the operator. Due to the high temperatures and pressures, most of the gas propellant tests were conducted here.



VICKERS' HOT gas motor system uses hydraulic components.

$1 Billion Budget Planned for ARPA in 1959

WASHINGTON—One enlarged item in the $40 billion-plus defense budget now being finalized is the proposed budget for the Advanced Research Projects Agency. Best estimates are that ARPA will ask for at least $1 billion when the fiscal year 1959 budget goes to Congress.

ARPA's FY 1958 budget is $550 million. Of this, $59 million was transferred, by executive order, to the National Aeronautics and Space Administration when it was formed in October. In addition, another $68 million of Air Force funds was transferred to the space agency.

All of the money has been set aside for "scientific" research. However, some projects which were transferred from ARPA to NASA, are in the "gray area" for both scientific and military application. But it is not felt that these projects violate the "peace charter" of the civilian space agency.

While the ARPA budget is considered one of the closest to an actual performance budget in the Pentagon, observers point out that like most budgets, the requested amount and the appropriated amount represent only the visible costs. In fact, one rule of thumb is that the visible budget indicates about half the total expenditure. The other half of the costs include support and development financing, and other costs borne by budgets of the forces or offices supplying the service.

Rear Admiral John E. Clark, deputy director of ARPA said in a recent speech that additional taxation might be required to finance the mounting defense budget.

'SPAGHETTI' TUBING construction of the *Pioneer X-15* engine is near the exit area of the nozzle. Engine, with infinite throttle capabilities and loaded with safety features has been designed for maximum protection of the pilot.

X-15 Engine Undergoes Tests

Lake Denmark, N.J.—The *Pioneer* engine for the Air Force *X-15* air-space vehicle will be a revolutionary first application of infinite-throttle operations for rocket engines in the United States.

The first engines for the research craft have been completed and are undergoing static tests here at Reaction Motors' captive test facilities. As many as 10 firings are made during each 12-hour day as each power plant is run through several evaluation checkouts. Engines are run with complete flight equipment including tanks, pumps and pressurization systems.

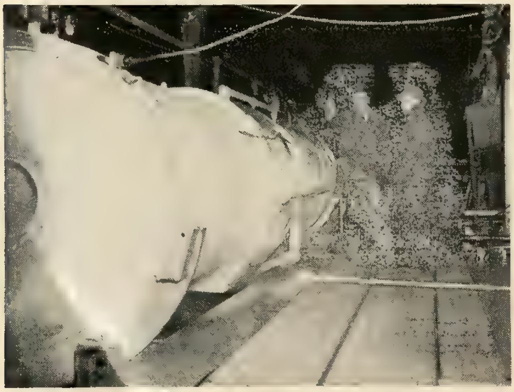
The *Pioneer* XLR99 RM-1 liquid propellant engine system has many safety features. Engineers proudly say that each safety device is backed up with another safety device. Reaction points out that the safety requirements of the system have been the major emphasis throughout the project.

Starting and stopping of the engine and thrust variation will be under full control of the pilot throughout flight. *Pioneer,* with a maximum thrust of more than 50,000 pounds, can be throttled from 100% output to idling condition over a smooth infinite variation of thrust. This contrasts with the *X-2* step thrust principle.

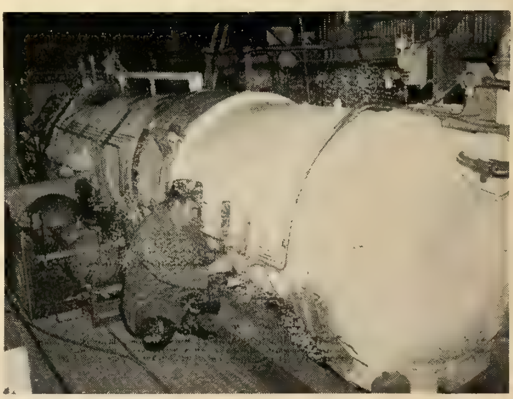
During the testing of the system, every conceivable malfunction is artificially created to insure complete reliability of the basic features of the system.

Reaction entered the *X-15* program with the award of a prime contract in February 1956. Current engine is an outgrowth of a 50 k *Viking* engine. Original *Viking* engine developed slightly over 20 k.

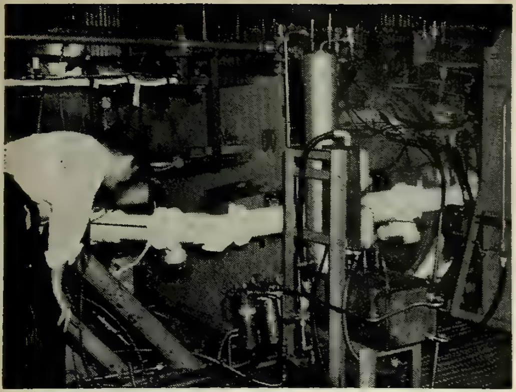
Deliveries of the first engines will begin next February. Early test flights will use two X-1 engines.



HEAVY FROST builds up on liquid oxygen and ammonia tanks during fueling of the *Pioneer* system prior to a night firing check-out at Lake Denmark.



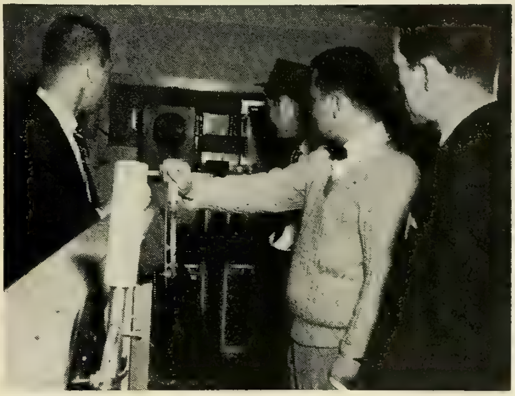
FINAL CHECK is made on instrumentation lines of oxygen tank. LOX is stored in the forward tank just aft of the pilot's cabin with ammonia tank amidship.



LIQUID OXYGEN flow line is examined as propellants are pumped into the system. *Pioneer* engine, pumps and pressurization system is to the left of the engineer.

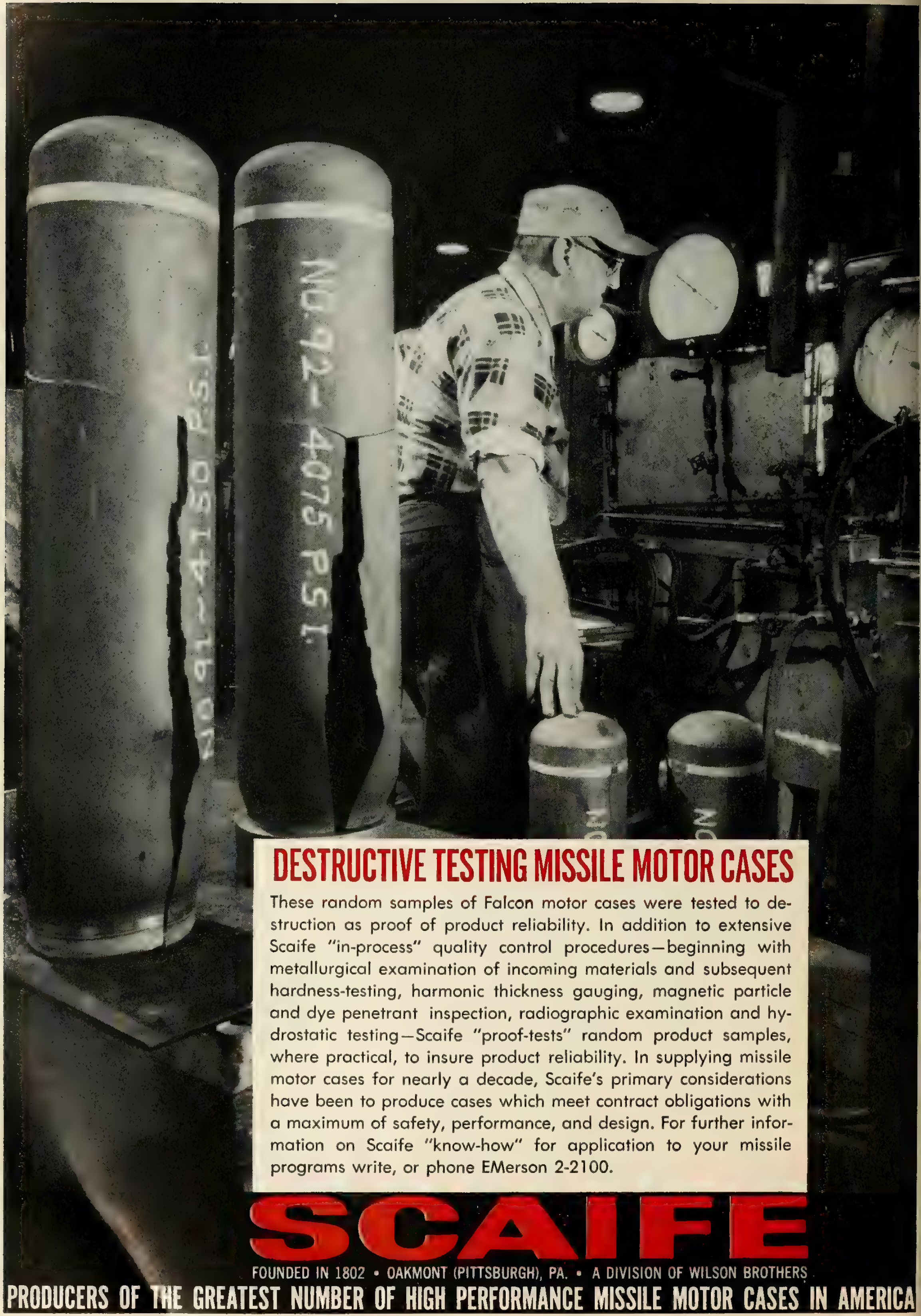
WHEN MALFUNCTION is induced, engineers check data sheets to detemine results after safety shutdown. From the left: Bernie Saber, Harry Burton and Ted Sjoberg.

TEST OPERATOR Edward Margetson, (l to r) Test Engineer Sjoberg, Technician Raymond Wodell, and Operator William Dunkelberger wait out malfunction fix.



OPERATOR DUNKELBERGER, operates *Pioneer* throttle as (l to r) Bob Mayer, Sjoberg and m/r editor Norman L. Baker watch a captive firing on remote TV.

ROCKET ENGINE lights up the Reaction Motors Lake Denmark test area as it is throttled through a full-cycle.



DESTRUCTIVE TESTING MISSILE MOTOR CASES

These random samples of Falcon motor cases were tested to destruction as proof of product reliability. In addition to extensive Scaife "in-process" quality control procedures—beginning with metallurgical examination of incoming materials and subsequent hardness-testing, harmonic thickness gauging, magnetic particle and dye penetrant inspection, radiographic examination and hydrostatic testing—Scaife "proof-tests" random product samples, where practical, to insure product reliability. In supplying missile motor cases for nearly a decade, Scaife's primary considerations have been to produce cases which meet contract obligations with a maximum of safety, performance, and design. For further information on Scaife "know-how" for application to your missile programs write, or phone EMerson 2-2100.

SCAIFE

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PRODUCERS OF THE GREATEST NUMBER OF HIGH PERFORMANCE MISSILE MOTOR CASES IN AMERICA

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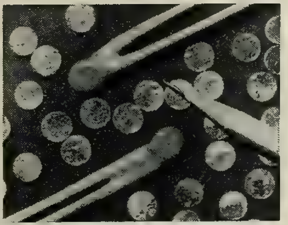


METALLIZED ceramic discs are heart of thermistors.

New Thermal Switches Resist Heat Increases

PITTSBURGH—Solid-state devices that act as tiny contactless thermal switches have been developed by the Westinghouse Electric Corp. The units are thermistors whose resistance increases abruptly when a specified desired temperature is attained.

Westinghouse sees their first practical application for over-temperature protection of hermetic motors. In this type of application, thermistors installed directly in the motor windings will operate a small external relay which de-energizes the motor or gives a signal when overheating occurs. The company expects to market hermetic motors with the new protective system shortly.

Applications such as this are possible because of the thermistor's ability to display an abrupt and substantial increase in resistance when its temperature rises to a specified point and its ability to return to nominal resistance value when cooled below that point or level.

Because of this, when temperatures of thermistors reach the critical point, they become high-resistance circuit elements and, with no moving parts, perform the function of a switch by effectively opening the circuit.

When temperature falls below the critical point, resistance returns to a relatively low value, so that in effect a conductor which closes the switch is inserted into the circuit.

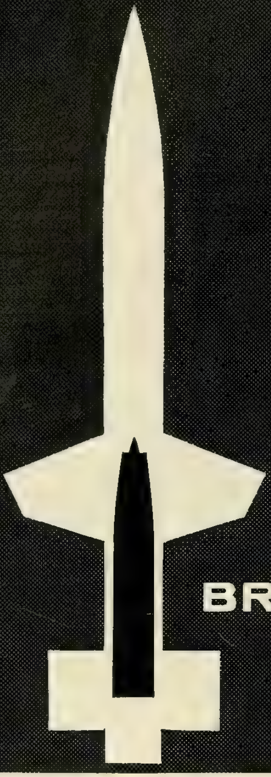
The new devices, termed Positive Temperature Coefficient Thermistors, increase in resistance with temperature in contrast with conventional thermistors whose temperature coefficient of resistance is negative. Another contrast is that within their respective operating ranges, the sensitivity of the units is many times that of conventional thermistors. Temperature ranges in which switching occurs are very sharply defined and are controllable.

By varying the composition of the thermistors, it is possible to precontrol both residual resistance and temperature level at which switching occurs. For example, thermistors for motor over-temperature protection will switch at specific temperatures between 100 and 125 degrees C and will function in control circuits requiring a 17:1 ratio of maximum to residual resistance.

The thermistors are small ceramic discs, roughly the size of aspirin tablets, that are surfaced on opposite faces with a metallic coating. Before use they are fitted with leads and encapsulated in an epoxy resin having proper thermal, electrical, and mechanical characteristics.

IN THIS DEMONSTRATION, thermistor at left displays its normal resistance at temperature of 100 degrees C. Thermistor, right, in boiling solution of ammonium chloride, displays resistance newly-developed roughly 20 times higher at about 112 degrees C.

BRAIN POWER



BRISTOL RAMJETS

THE PROBLEM. To realise for civil and military use the staggering potential of the ramjet engine—the jet engine with no moving parts that promises to prove the most efficient method of propulsion inside the earth's atmosphere.

THE ANSWER. Bristol teams designed and developed efficient ramjet engines. They flew many hundreds of supersonic test vehicles, since, of course, ramjets must be tested in the environment in which they are destined to operate.

This work culminated in the Bristol Thor, the power-plant for the Bristol/Ferranti Bloodhound Guided Missile. But in producing Thor, Bristol built up Europe's most extensive experience of the ramjet and the most complete facilities for its further development.

And developed it will be. For today, the world's designers are beginning to see in ramjet engines the means of making *civil* supersonic travel a practi
economic reality.

How well has the brief been fulfilled?

The Bloodhound can best answer for the military appli
tion.

Security forbids publication of the full facts, but
much can be said. The Bloodhound already approac
full operational status with the RAF and has been orde
by Sweden. With the range and speed imparted by
Bristol ramjets, the Bloodhound has greater effective
than any other surface-to-air guided missile in the west
world. And when future defence needs dictate even hig
speeds, even longer ranges, even heavier armament, th
needs can be met without major alteration or redesig
the ramjet-powered missile and its system.

Ramjet power for manned aircraft is the next stage.

Other famous Bristol Siddeley engines:-

ARMSTRONG SIDDELEY SAPPHIRE—turbojet . . . high subs

FLIGHT POWER

upersonic speeds . . . powerplant of the Handley Page r bomber.

OL PROTEUS—most powerful jet-prop in airline service emarkable mechanical excellence and exceptional relia- . . . in the Bristol Britannia.

TRONG SIDDELEY VIPER—turbojet . . . exceptional hand- qualities . . . powers the Hunting Jet Provost, RAF's jet trainer, and the Jindivik pilotless target aircraft.

OL ORPHEUS—outstanding lightweight medium-thrust jet . . . already specified for 14 different aircraft in ntries.

TRONG SIDDELEY SINGLE MAMBA—jet-prop . . . stressed aval operations such as deck landing and catapulting nstalled in the Short Seamew.

OL OLYMPUS—turbojet . . . remarkable for great power gh altitude and very low fuel consumption . . . powerplant e Avro Vulcan bomber.

TRONG SIDDELEY DOUBLE MAMBA—jet-prop . . . virtually twin-engined reliability for long oversea reconnaissance duties . . . powers the Fairey Gannet anti-submarine aircraft.

BRISTOL CENTAURUS AND HERCULES—two radial piston engines, with Bristol-pioneered sleeve-valves . . . renowned for their reliability and long overhaul life.

Bristol Siddeley

ENGINES LIMITED

BRAIN POWER translated into FLIGHT POWER

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IN HOSE

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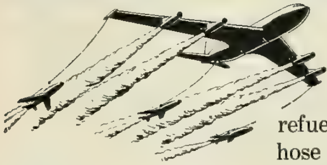

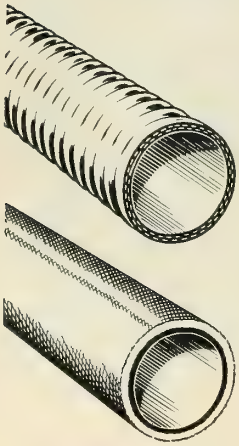

IN-FLIGHT REFUELING HOSE? Vital feature of the probe and drogue method of refueling is the compact, easy-to-handle hose and integral coupling assembly developed and manufactured by Hewitt-Robins. Aerodynamically balanced hose trails at high speed without wobbling, absorbs tremendous shock loads, and provides maximum safety.

VACUUM HOSE? Exceptional flexibility under extreme temperatures combines with long life in H-R reinforced synthetic rubber or silicone vacuum hose. Lengths and diameters for all high-performance applications.

JET STARTER HOSE? For hot or cold air starts using various elastomers. Also specially designed wire braided constructions for recharging self-contained air bottles.

Hewitt-Robins, prominent in development of aircraft refueling hose, makes many rubber products for the aircraft and missile industries. These components are fabricated using all elastomers, including silicones by themselves or with various fabric or metal reinforcements.

Specialists in our Aircraft Products Department can help you put today's new silicone and rubber compounds to best use in aircraft, missiles, and rockets. For information, service, or your copy of comprehensive Product Bulletins, contact your local H-R representative, or Hewitt-Robins, Stamford, Connecticut.

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Metal Joining

Ultrasonic Techniques Used by Aeroprojects

by Peer Fossen

West Chester, Pa.—The problem of joining similar and particularly dissimilar metals has long plagued electronic equipment designers, engineers, and production people, especially those working in the miniature component field.

Many new concepts have been tried out, with varying degrees of success, to achieve better and more reliable joints, with government and industry pouring large amounts of money into research and development. Results of R&D are now becoming evident.

The most fascinating development in the field is the application of ultrasonic techniques for metal joining. Aeroprojects Inc., West Chester, Pa. today is offering on the market production type ultrasonic equipment which will become extremely important tools in the electronics industry before long.

• **Started 10 years ago**—Aeroprojects began its work to develop these metal-joining tools some 10 years ago after laboratory research had proved ultrasonics potential in the field. Before, very little had been done to develop ultrasonic energy into a useful production tool, and the company's basic objective was to bridge the gap between laboratory research and industrial applications.

Most important in Aeroprojects' present line of metal-joining equipment are ultrasonic welding, soldering and brazing tools manufactured and marketed under the tradenames Sonoweld, Sonosolder and Sonobraze. A subsidiary, Sonobond Corp. is responsible for actual manufacturing and marketing.

Besides producing the hardware, Sonobond offers production engineering services, recognizing that "off-the-shelf" ultrasonic equipment is seldom satisfactory and that each production application usually requires special "tailor-made" engineering and tooling. Engineering pilot plants devote substantial effort to each new production requirement, devising special tooling, and establishing the most efficient techniques for utilizing the equipment.

• **Ultrasonic welding**—This can be described as a method for bonding similar or dissimilar metals by introducing vibratory energy into the metals

NEW
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THE PRE-PACKAGED LIQUID ROCKET ENGINE
ready for instant firing
includes entire engine system
factory fueled
no propellant handling in the field
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A unique concept in liquid propellant rocket engines, the pre-packaged powerplant developed and now being produced by Thiokol's Reaction Motors Division stands as one of the most significant recent advances in the field of rocketry. It is high on reliability; can be held in "ready" state for extended periods of time; and in design will lend itself to many missile applications.

In your future development programs, you can consider pre-packaged liquid rocket engines as being available!

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®Registered trademark of the Thiokol Chemical [illegible] for its liquid polymers, rocket propellants, plasticizers and other chemical products in the areas to be joined. The process produces a solid state metallurgical bond. Two types of equipment are being used for this type of welding—the spot-type welder, and the continuous roller seam welder.

Aeroprojects line of welding equipment includes a variety of sizes and types. The largest spot-welder at present is a 4000-watt unit used for joining medium-heavy gages of materials such as aluminum and copper and the somewhat thinner gage sheet of metals and alloys that are more difficult to weld—titanium, zirconium, molybdenum, Inconel.

The spot-type welding units are also manufactured in sizes all the way down to 100-watt instrument welders for joining fine wires and thin foil materials. The spot-welders can be used for either single spots or over-lapping spots to produce continuous bond.

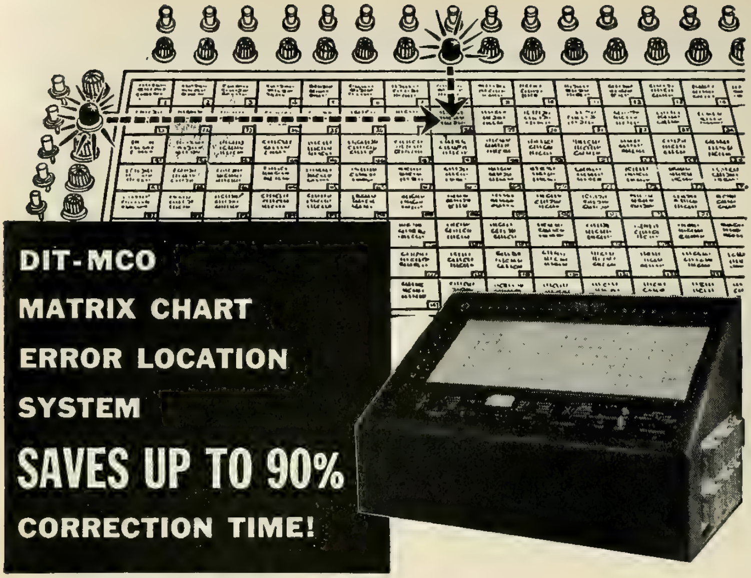
Ultrasonic welding equipment consists basically of a transducer coupling system for generating vibratory energy and delivering it to the weld zone, a support for the work pieces, a means for applying clamping force to the weldment, and ultrasonic generating equipment for driving the transducer.

• **Wide size range**—Aeroprojects has developed ultrasonic transducer-couplings for applications utilizing both magnetostrictive nickel stacks and electrostrictive barium titanate as transducing materials and couplers of various materials and configurations. Sizes range from jewelry-type equipment that operate on power of less than one watt to massive equipment that require kilowatts of power.

A basic and significant development is the force-insensitive transducer-coupling system that permits the application of high forces of the system without draining great amounts of vibratory energy into supporting members and without shifting the system frequency to destroy resonance.

This mount can be hermetically sealed to a vessel wall so that the ultrasonic energy can be transmitted through a coupler into an atmosphere of high pressure or vacuum at very high or low temperatures or into toxic, corrosive, or radioactive materials without exposing the transducer or other sensitive parts of the equipment to such environment.

A substantial number of ultrasonic generators of Aeroprojects' design have been developed for driving transducers in the frequency range of 5 kilocycles to 3 megacycles per second and having power production application. Increasing emphasis is being placed on



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DIT-MCO's revolutionary Matrix Chart is the only error location device which puts all circuit information . . . errors, circuit numbers, type of flaws, etc. . . . directly in front of the operator of this Automatic Electrical Circuit Analyzer. It plots the entire test sequence and pinpoints every circuit flaw . . . instantly! Horizontal and vertical indicator lights cross reference to indicate the exact error location, circuit number and type of flaw. As errors are detected, they are recorded on the proper matrix square and the test continues.

Once the test sequence has been completed, all corrections are made direct from the Matrix Chart. This *group correction* feature saves up to 90% of error correction and/or interpretation time by eliminating time-consuming searches through complex manuals and wiring diagrams. After corrections have been noted on the Matrix Chart, it provides a complete record of test circuits, test specifications, instructions, results and modifications. This concise, understandable record improves interdepartmental communications and provides co-ordination through all stages of planning, production and maintenance. Non-technical personnel easily master operation of the Analyzer and use of the Matrix Chart System. The final Matrix Chart can follow the product for future overhaul and maintenance use.

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PLUGBOARD PROGRAMMING SPEEDS TESTING!

Jumper-wired plugboard programming permits use of simple, straightforward adapter cables. Circuit modifications never present headaches because all changes are easily made by re-jumpering the readily accessible plugboards.

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the use of rotating motor-alternator sets for driving transducers.

One of the most important advantages of ultrasonic welding is its ability to join dissimilar metals formerly considered impossible to weld together. And since this type of welding does not involve fusion, combinations of dissimilar metals can be welded to each other without the formation of intermetallic compounds. The following indicates some combinations that have been successfully welded on Aeroprojects equipment:

Material	Bi-Materials
Aluminum	Tin, Nickel, Beryllium, Tantalum, Molybdenum, Silver, Copper, Gold, Magnesium, Titanium, Steel, Germanium, Kovar, Zircaloy
Silicon	Aluminum, Gold
Germanium	Gold, Aluminum, Platinum
Copper	Kovar, Aluminum, Nickel
Nickel	Kovar, Platinum, Molybdenum, Aluminum, Steel, Copper
Molybdenum	Tantalum, Aluminum, Nickel
Zirconium	Aluminum, Copper, Steel
Platinum	Nickel, Aluminum, Gold, Germanium, Kovar
Gold	Platinum, Aluminum, Nickel, Silicon, Kovar, Germanium

Ultrasonic welds of high structural integrity can be made by joining many dissimilar metals. The data shown below has been obtained on Aeroprojects equipment when making bi-metal welds in materials and thicknesses as indicated.

Thickness and Material	Average Spot Strength
0.042" Low Carbon Steel to 0.050" 2024-T3 Alclad Aluminum	860±100
0.042" Copper to 0.061" 1100-H14 Aluminum	850±30
0.031" 6061-T6 Aluminum to 0.030" 321 Stainless Steel	870±30
0.028" Titanium 5 A1-2.5 Sn to 0.025" 430 Stainless Steel	940±30

Other important features of ultrasonic welding are low power requirements (in some cases as low as 5% of that required by ordinary resistance welding); low clamping forces resulting in negligible external deformation; precleaning normally limited to degreasing; (postcleaning unnecessary); and ease of operation.

- **Ultrasonic soldering**—The devel-

Major Southern California missile operation has

immediate openings

for qualified graduate engineers with experience in

Instrumentation Systems

with general knowledge of missile systems, including propulsion, guidance, structures and electrical systems.

Guidance Systems

Experienced in research and testing of practical hardware, and with mathematical background for systems analysis.

Flight Test

Background should qualify for planning and formulating entire flight test programs.

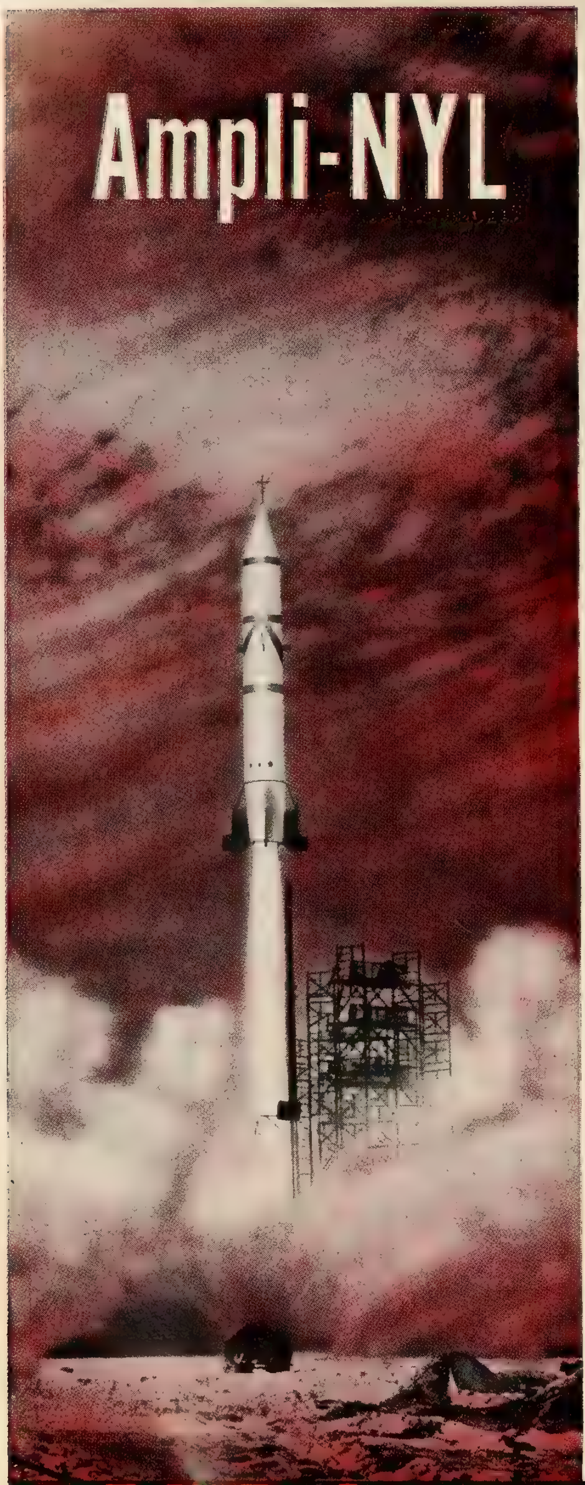
Aerodynamics

Must be able to analyze missile configuration to determine aerodynamic performance and stability and control characteristics.

For information on these and other engineering positions, write:

Mr. H. B. Richards, Dept. 451
Missile Division
North American Aviation, Inc.
12214 Lakewood Blvd., Downey, California

MISSILE DIVISION
NORTH AMERICAN AVIATION, INC.

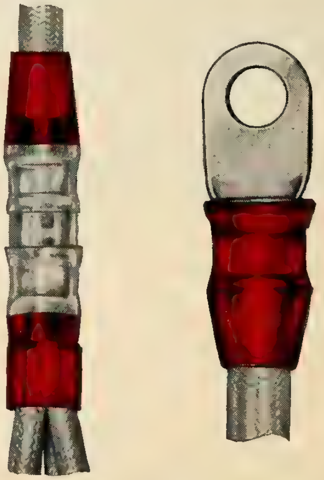


the entirely NEW insulated A-MP terminal line for large wire sizes

FEATURES:

- High Performance Nylon Insulation to provide continued satisfactory service life at elevated temperatures, plus resistance to ester-based oils.
- Helical tongue design to secure maximum structural utility at minimum weight penalty.
- Cast insulation has formed entry ramp to provide easy wire insertion and snug fit over standard AN wires.
- Color-coding to assure proper terminal selection for applicable wire sizes.
- Step-Lok Crimp to guarantee continued proper position of insulation with respect to terminal.
- Connector designs are available in single to single, single to multiple and multiple to multiple wire accommodations.

The A-MP Ampli-NYL Terminal is installed with the proven Confined "C" Crimp for maximum electrical and mechanical performance. Confining the spread of the terminal during the crimping process achieves more intimate contact and a homogeneous union of conductor and terminal.



Additional information is available upon request.

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GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through wholly-owned subsidiaries in: Canada • England • France • Holland • Japan

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opment of new metals and alloys created a soldering problem. Many of the new materials proved highly resistant to uniting with solder, and although chemical fluxes used in standard soldering methods ordinarily overcomes this resistance, the flux itself creates new problems, especially where corrosion is a critical factor.

To overcome these problems, Aeroprojects has developed a line of ultrasonic soldering tools for fluxless soldering and metal coating. These tools will solder silicon, germanium, aluminum, copper, silver, magnesium and other unusual materials.

The ultrasonic solder tool can be used for single tip operation, or for multi-point soldering with 5 to 50 tips.

- **Ultrasonic brazing**—Aeroprojects ultrasonic brazing equipment is used for brazing of aluminum and for other low-temperature brazing work. Several models have been developed. Some of these operate with gas heat while others are electrically heated.

Ultrasonic brazing, like ultrasonic soldering, insures joints free of contamination often left by flux in conventional brazing operations. It also eliminates the cleaning operation often required after conventional brazing.

New Measurement Jargon Springing up in Industry

New York—Measurement accuracy of a tenth of a millionth of an inch will probably be attained in the United States within the next 10 years. This is the prediction of Louis F. Polk, vice-president and group executive of Bendix Aviation Corporation.

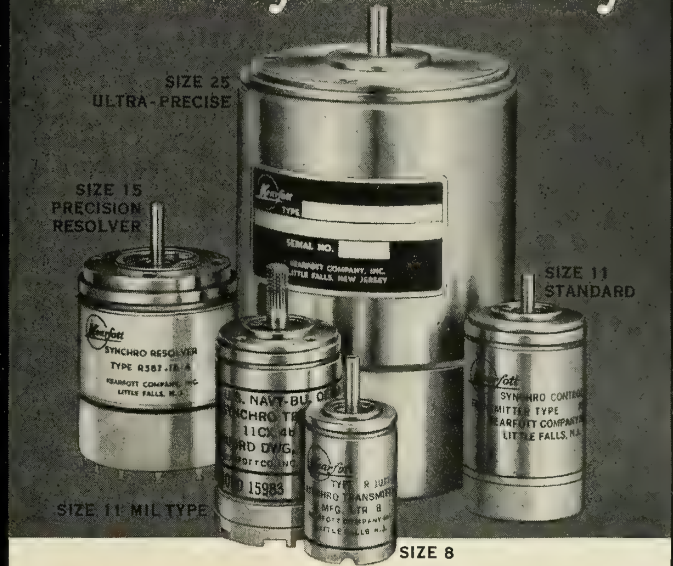
Polk pointed out that some plants today are manufacturing grinding, honing and other machine tools and measuring equipment for volume production of precision parts to an accuracy of plus or minus five millionths of an inch (six decimal places).

"But in the aircraft and missile fields, we have practical requirements for seventh-decimal-place accuracy right now," he said. "Projected piloted plane speeds of more than 4500 miles an hour and missile altitudes of up to 240,000 miles with speeds of more than 24,000 miles an hour present incredible precision requirements in making such parts as gyros, control systems, power linkages and various sensing devices," he added.

The Bendix official said advanced research in such fields as nuclear energy is developing new concepts of measurement complete with new jar-

Synchros...another Kearfott capability

accuracy...reliability



SYNCHROS FOR EVERY APPLICATION

Kearfott offers the widest range of synchros in the industry. Ruggedly constructed of corrosion-resistant materials, they give unequalled performance under every environmental condition. For best characteristics and reliability, specify Kearfott for all your synchro requirements. Here are a few typical models:

Size 8: .750" x 1.240". 1.75 oz. −54C to +125C. Available as transmitter, control transformer, resolver, and differential. Max. error from EZ: 10, 7 and 5 minutes.

Size 11 Standard: 1.062"x1.766". 4 oz. −54C to +125C. Available as transmitter, control transformer, repeater, resolver and differential for 26v and 115v applications. Max. error from EZ: 10,7 and 5 minutes standard, 3 minutes in 4-wire configurations.

Size 11 MIL Type: Dimensions and applications same as above. Meets Bu. Ord. configurations: max. error from EZ: 7 minutes.

Size 15 Precision Resolver (R587): With compensating network and transistorized booster amplifier, provides 1:1 transformation ratio, 0° phase shift. Max. error from EZ: 5 minutes.

Size 25 Ultra-Precise: 2.478" x 3.187". 45 oz. Available as transmitter, differential, and control transformer. Max. error from EZ: 20 seconds arc.

***Engineers:** Kearfott offers challenging opportunities in advanced component and system developments.*

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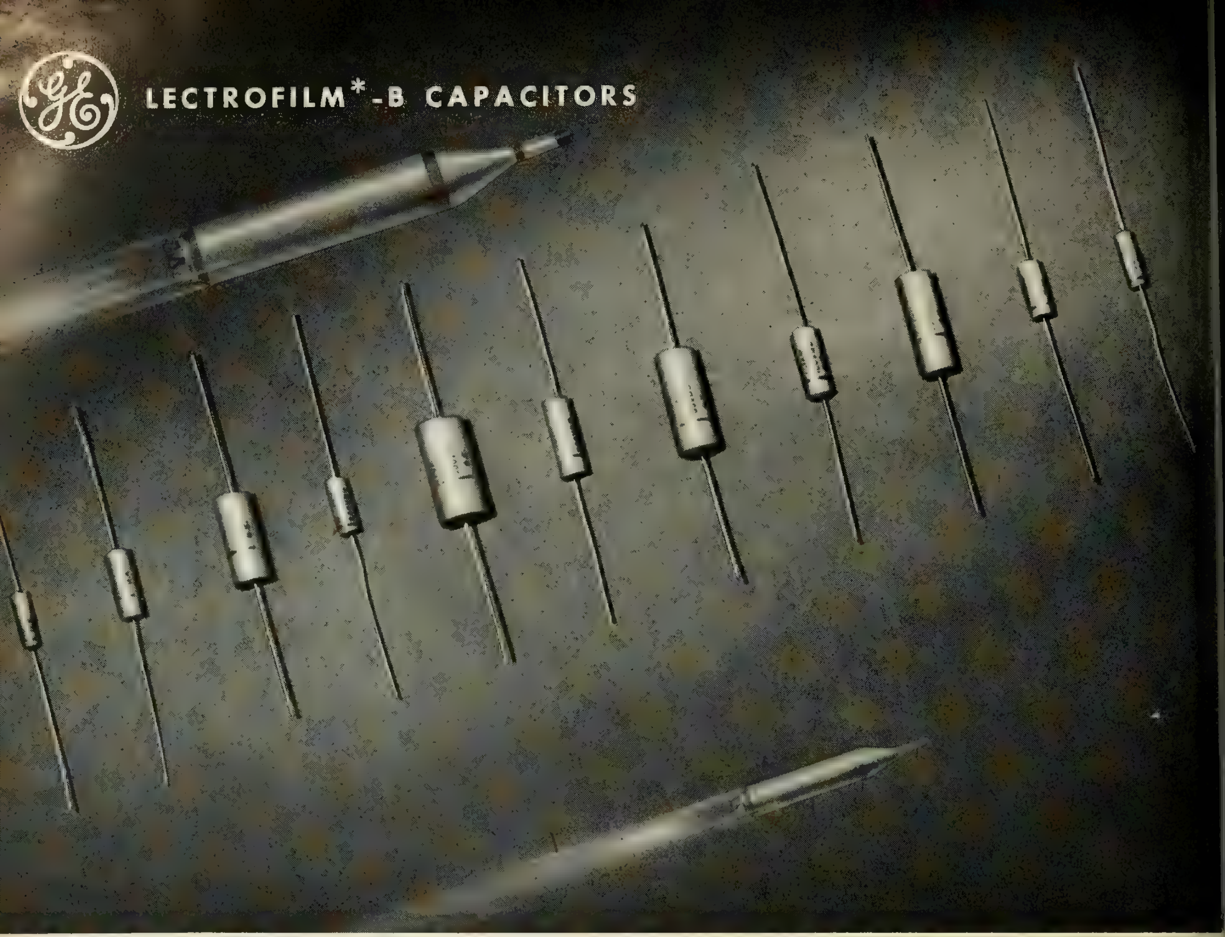

General Electric Announces for Missile Use . . .

New Lectrofilm*-B Capacitors for 44,000 Hours of Reliable Life

New G-E Lectrofilm-B capacitors offer you maximum reliability at lowest possible cost . . . results of over 3,000,000 unit-hours of life test data (per G-E Spec. MTC-3) indicate a probability of survival in excess of 0.99 for 44,000 hour life under rated voltage at 85C. Under rated voltage at 125C, the indicated probability of survival is in excess of 0.98 for 44,000 hour life.

LOW FAILURE RATE AND LONG LIFE of these inexpensive G-E capacitors result from using only the highest quality materials and the closest of process controls . . . units are tightly wound with high-purity aluminum foil and capacitor-grade Mylar† film dielectric. No solder is used, and introduction of contaminants through impregnation is eliminated.

SMALL, LIGHTWEIGHT ENCLOSURE consists of tape wrapped around the compact roll and sealed with epoxy resin, forming a rugged case which resists humidity, vibration and shock.

TO MEET YOUR APPLICATION REQUIREMENTS, 14 case sizes are available in five ratings—100-, 200-, 300-, 400-, and 600-volts. Capacitance range within each rating is: 0.015 to 0.68 uf in 100 volts; 0.010 to 0.47 uf in 200 volts; 0.0047 to 0.22 uf in 300 volts; 0.0033 to 0.15 uf in 400 volts; and 0.0010 to 0.10 uf in 600 volts.

GET A QUOTATION TODAY ON NEW LECTROFILM-B CAPACITORS by contacting your General Electric representative. Ask for your copy of life-test data and G-E Specification MTC-3. Or, write to Section 447–4, General Electric Co., Schenectady, N. Y.

*Trade-mark of General Electric Co. †Reg. trade-mark of DuPont Co.

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gon. For example, he cited the estimated weight of an electron as one-thirtieth billion, billion, billion billionths of an ounce. A "jiffy," he said, is the time required for light (going at the speed of 186,000 miles a second) to travel one centimeter. A "barn," which is an area used to measure atom action, is the part of a square centimeter that would be expressed by the fraction 1 over 1 followed by 24 zeros. A "shed" is one-millionth of a "barn."

JPL Utilizing U.M. 'Scope for Probe Tracking

Ann Arbor—Radio astronomy antennas used by the Army for tracking its first moon satellite will once again show the continuing feedback between basic and applied research, says a University of Michigan astronomer.

Prof. Leo Goldberg, director of the University Observatory, said the Army's Jet Propulsion Laboratory (JPL) at California Institute of Technology has an antenna and receiver ready for the moon probe at Goldstone, Arizona.

JPL, according to Goldberg, studied several antenna designs before going through with a crash program to track the moon probe.

The instrument finally selected by JPL is an exact replica of the university telescope now nearing completion at Peach Mountain near here.

The instrument, however, will have a different receiver and is designed for basic research of gas clouds, galaxies, the sun, and other celestial bodies and phenomena.

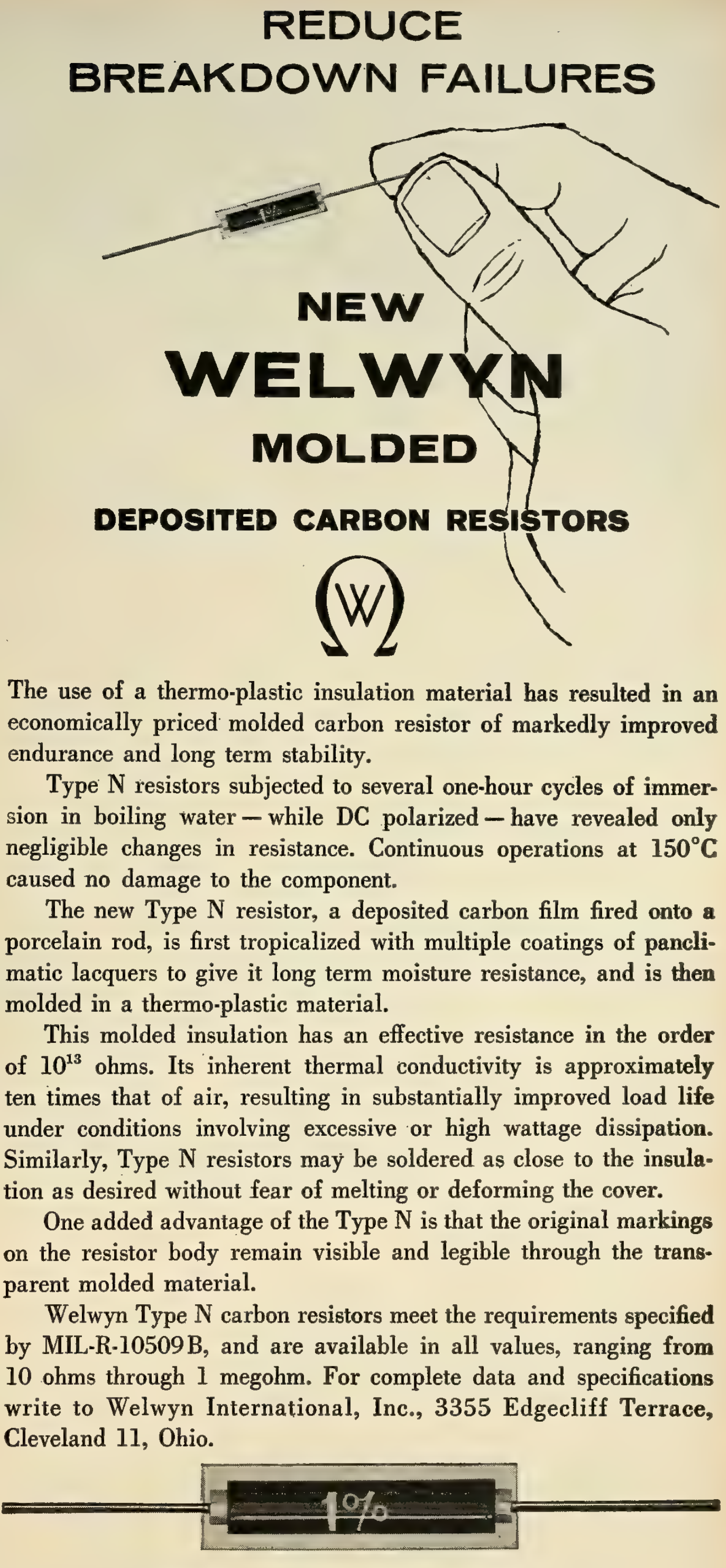
"JPL found that our antenna, which was previously to be the first of its kind in the nation, was best for tracking the moon satellite. It ordered an identical antenna from the same company that manufactured ours," Goldberg said.

Why did JPL choose the university design? One reason, according to Goldberg, was because of the large (85-foot) dish-shaped surface and ease of steering.

Perhaps even more importantly, it has a very precise surface. (Precision and sensitivity are needed to pick up high frequency waves and information from great distances in space.)

• **Tracks rapidly**—With such equipment, JPL found it could track a satellite rapidly moving away from earth and learn such things as its speed, direction, and other pertinent data.

Astronomers in Manchester, England, home of the world's largest (250-foot) radio telescope, tracked *Sputnik*



REDUCE
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WELWYN
MOLDED
DEPOSITED CARBON RESISTORS

The use of a thermo-plastic insulation material has resulted in an economically priced molded carbon resistor of markedly improved endurance and long term stability.

Type N resistors subjected to several one-hour cycles of immersion in boiling water — while DC polarized — have revealed only negligible changes in resistance. Continuous operations at 150°C caused no damage to the component.

The new Type N resistor, a deposited carbon film fired onto a porcelain rod, is first tropicalized with multiple coatings of panclimatic lacquers to give it long term moisture resistance, and is then molded in a thermo-plastic material.

This molded insulation has an effective resistance in the order of 10^{13} ohms. Its inherent thermal conductivity is approximately ten times that of air, resulting in substantially improved load life under conditions involving excessive or high wattage dissipation. Similarly, Type N resistors may be soldered as close to the insulation as desired without fear of melting or deforming the cover.

One added advantage of the Type N is that the original markings on the resistor body remain visible and legible through the transparent molded material.

Welwyn Type N carbon resistors meet the requirements specified by MIL-R-10509B, and are available in all values, ranging from 10 ohms through 1 megohm. For complete data and specifications write to Welwyn International, Inc., 3355 Edgecliff Terrace, Cleveland 11, Ohio.

SAMPLES AVAILABLE ON REQUEST.

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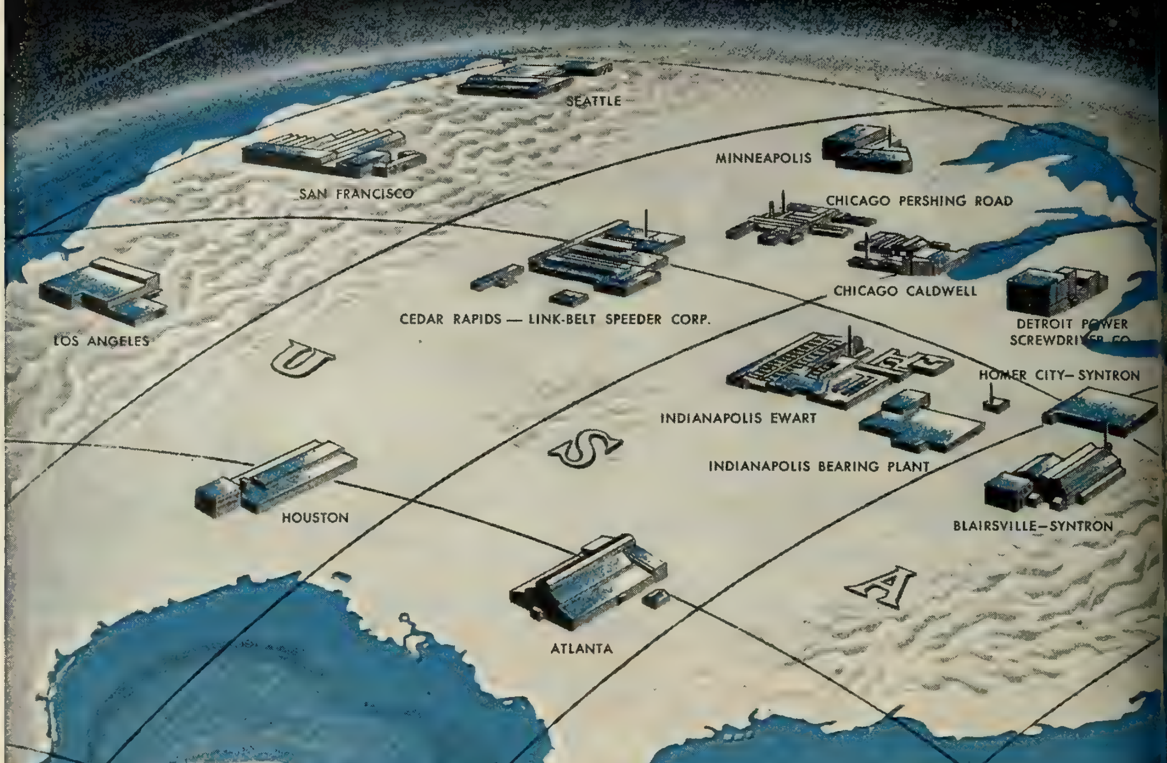
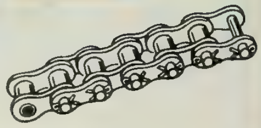
One of America's major industrial organizations offers immediate availability of a complete line of mechanical power transmission components. *We invite you to investigate . . .*



17 LINK-BELT PLANTS AND 40 DISTRICT OFFICES are located strategically to all key industrial areas.



ROLLER CHAIN. Noted for exceptional dynamic strength. A full range of pitches and widths, as well as matching sprockets.

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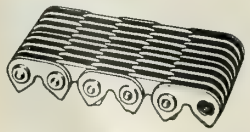
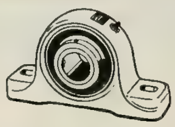
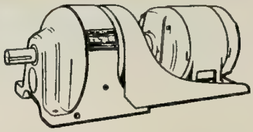


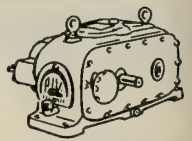
SILENT CHAIN. Better than 98% efficient; the ideal drive for high speeds, large ratios. Pitches as small as 3⁄16-in.



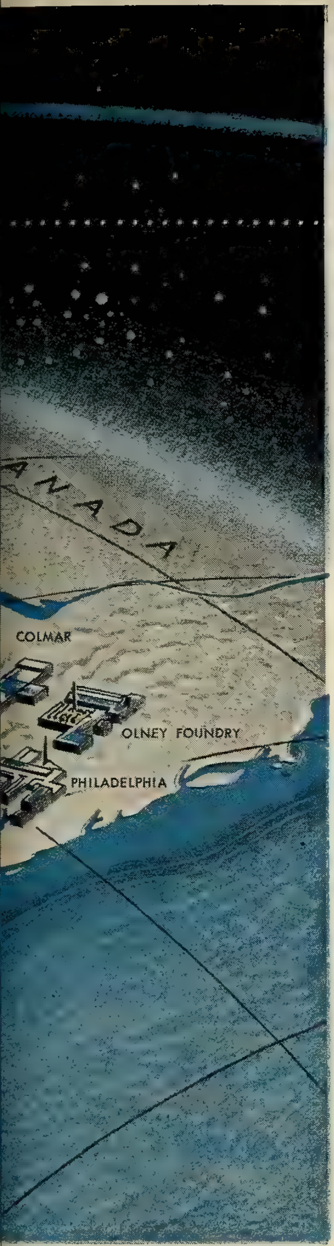
BEARINGS. Self-aligning ball and roller types in all popular mountings. Also a full line of babbitted and bronze bearings.



SPEED REDUCERS. Gearmotors, Motogears, In-Line helical, parallel shaft, worm, fluid and shaft-mounted gear drives.



P.I.V. VARIABLE SPEED DRIVES. Positive and infinitely variable. The only chain-driven variable speed control.



HOW LINK-BELT CAN SERVE YOUR MISSILE PROJECTS

Of importance to those agencies and manufacturers at work in missile and rocket ground support, handling and test equipment:

Throughout industry, Link-Belt Company is acknowledged as a primary producer of equipment for the mechanical transmission of power and moving materials. Chains, sprockets, bearings, speed reducers, conveyors —industry looks to Link-Belt as one complete and capable source.

Of definite advantage in applications involving component combinations is the in-built integration of Link-Belt products. They're made to match, and can be assembled without securing installation data from other suppliers. Not to mention the obvious purchasing economies that accompany one-source supply.

Below are included just a few of the products which Link-Belt offers on an "off-the-shelf" basis. Literature on all products shown below is available: Please write to the Link-Belt Executive Offices. Address: Dept. MR, Prudential Plaza, Chicago 1, Ill.

15,004

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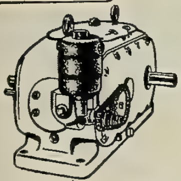
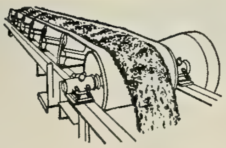
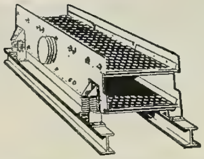


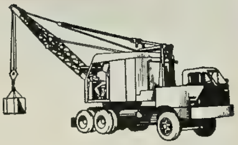
P.I.V. AUTOMATIC CONTROLS. Pneumatic, mechanical, electronic and hydraulic types for precise speed changing.



CONVEYORS. Belt, screw, trolley, chain, oscillating and drag types; bucket elevators, haulage machines and component parts.



VIBRATING EQUIPMENT. Link-Belt vibrating screens, Syntron equipment for feeding, conveying, elevating and packing.



LINK-BELT SPEEDER SHOVEL-CRANES — crawler and rubber-tired models in a capacity range from 8 to 75 tons.

Circle No. 16 on Subscriber Service Card.

I with their equipment. However, the Manchester instrument is designed to pick up lower frequency radio waves.

Illustrating the recent history of the feedback between applied and basic research, Goldberg says that since the beginning of radio astronomy more than 25 years ago, the relationships between the two seemingly similar methods of research have been strengthened.

"In 1932 the Bell Telephone Co. laboratories in New Jersey put a young electrical engineer named Karl Jansky to work searching for a 'mysterious' interference which was disturbing wireless radio communications," he said.

"Jansky set up an antenna in a field and noted, over a period of days, that in certain directions static causing disturbances was stronger than in others. He measured the static's intensity and found it was always most intense from the direction of the Milky Way. Jansky concluded that the static was cosmic in origin and was coming from the galaxy."

The young scientist published a paper describing his findings but the static couldn't be eliminated and Bell discontinued work on the problem. "This was the beginning of radio astronomy," Goldberg said, "and several years later the problem was taken up by basic researchers. Again the feedback was illustrated."

Then it was found that there are short-lived, small clouds of gas of varying density in the atmosphere, and that when the beam of high frequency radio waves sent out by radio and TV chanced to hit the blobs of gas, they were reflected back downward.

• Waves fluctuate—It was noted, too, that the amount of radio waves reflected by these clouds fluctuated depending on the frequency and life of the blobs, Goldberg said.

With large antennas, it was reasoned, much of the sky could be covered and consequently a large number of "blobs." Thus, as one gas cloud faded out, another would be coming into the antenna's range, with the end result a continuing scattering of waves from the area between the troposphere (10 miles above Earth) to the ionosphere (50 miles in height).

With this new knowledge, waves could be sent out in huge quantities of energy by large antennas and received in large quantities, though some, of course, would escape through the electrically-charged ionosphere. An example of the usefulness derived from solving this basic problem is the transmission of high frequency TV waves from Key West, Fla. to Cuba—sending and receiving waves across water.

Entire new industries have been based on new knowledge concerning electronics, much of it through basic research, Goldberg adds. In Massachusetts, near MIT and Harvard, several small industries have sprung up in support of basic information of general importance to electronics. The same goes for California.

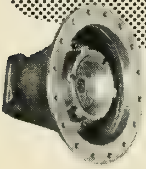
With the advent of *Sputnik*, designed by the Soviets for basic research during the International Geophysical year, has come still greater strides in technology and once again a feedback to basic researchers is apparent, Goldberg declares.

"In just a few years, both basic and applied research in radio astronomy has developed tremendously," he says. "Cooperation between government, industry and education in solving the many complex problems in astronomy and space research has helped immensely. But it's only the beginning. Whole new areas in these fields are on the threshold of development."

Buckeye

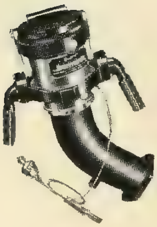
KEEPS THE PRESSURE ON

FUEL SERVICING



ADAPTERS

- Tapered seat, self-centering, cannot cock. Internal contour provides *maximum flow with minimum pressure loss.*
- Provide the most efficient form of connection for single point fueling.
- Type A-5, with one of several variable housings shown. Types A-2, A-3, A-4, and A-6 also available.
- All adapters meet General Specification MIL-A-6425A.



COUPLING VALVES

- Self-sealing coupling valves mate with adapters shown above to make positive leakproof connection for transfer of fuel. Full flow, minimum pressure drop.
- Valve can be connected or disconnected under pressure without loss of fuel.
- Type D-1, illustrated, meets Specification MIL-N-5877A.
- Other styles available.

BUCKEYE IRON & BRASS WORKS
DEPT. MR, BOX 883, DAYTON 1, OHIO

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Circle No. 22 on Subscriber Service Card.→

AERO-THERMODYNAMICISTS EXPLORE HIGH-SPEED RE-ENTRY

A report to Engineers and Scientists from Lockheed Missile Systems — where expanding missile programs insure more promising careers

Advanced weapon system technology has brought to the forefront problem areas requiring attention to interaction between aerodynamic and thermodynamic phenomena. Typical of these is the problem of high-speed atmospheric re-entry.

Expanding research and development activities have coincided with acceleration on top priority programs like our Polaris IRBM. At the same time, positions for qualified engineers and scientists have opened up that are unequalled in responsibility or in opportunities for moving ahead.

Positions in **aero-thermodynamics** include such areas as: aerodynamic characteristics of missiles at high Mach numbers; missile and weapon system design analysis; boundary layer and heat transfer analyses in hypersonic flow fields; and calculation of transient structural and equipment temperatures resulting from aerodynamic heating and radiation.

In addition, openings exist at all levels in **Gas Dynamics, Structures, Propulsion, Test Planning and Analysis, Test Operations, Information Processing, Electronics,** and **Systems Integration.** For these and other positions, qualified engineers and scientists are invited to write Research and Development Staff, Dept. 2912, 962 W. El Camino Real, Sunnyvale, California.

Lockheed / **MISSILE SYSTEMS DIVISION**

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO

Maurice Tucker, Aero-Thermodynamics Department Manager, right, discusses combined aero-thermodynamic re-entry body tests being conducted in Division's new "hot-shot" wind tunnel. Others are Dr. Jerome L. Fox, Assistant Department Manager, Thermodynamics, left, and Robert L. Nelson, Assistant Department Manager, Aerodynamics.

Propulsion by Nuclear Explosions Under Study

Los Alamos—A method of propelling a rocket by a series of small nuclear explosions is being studied by a group of theoretical physicists and mathematicians at the University of California's Los Alamos Scientific Laboratory.

This method was first outlined in 1947 by Dr. Stanislaw Ulam, research advisor at the Laboratory and co-developer of the hydrogen bomb. It was later taken up and extended by T. B. Taylor, former staff member at Los Alamos, who is now with General Atomic Division of General Dynamics Corp.

Studies at Los Alamos will determine how effectively blasts from explosions can be directed to get the maximum push on the rocket from given masses of exploding materials. Each explosion would give the rocket an extra push forward. Care has to be taken to avoid subjecting the rocket structure to excessively high pressures and temperatures, but Dr. Ulam believes this method might give several times more push for each pound of propellant than by the reactor method.

If studies are successful, they will point the way to a possible method of propelling space ships through the solar system.

In development of this concept, the laboratory will share ideas and information with the group at General Atomic, which has a contract to consider the possible structure and operation of such a space ship.

Analog Computer Uses Time Division Multiplier

Washington — Development of components for an all-electronic analog computer facility described as sufficient to simulate modern guided missile systems is reviewed in a report just released to industry through the Office of Technical Services, U.S. Department of Commerce.

The proposed computer, according to the report, is designed to operate on a 1:1 time scale and utilize a method in which programming could be done off the machine. This method would make it possible to store problems solved in as complete a form as possible.

The computer, called the Dynamic Systems Synthesizer, uses a high precision electronic time division multiplier and an electronic chopper which eliminates the electromechanical vibrators from the DC amplifiers. An electronic function generator using silicon diodes eliminates the need for servo function generation.

Tests were made of one or more of the components and of the proposed programming systems on a model computer. The results, according to the report, indicate the practicability of such a computer.

The report, PB 151137 Dynamic Systems Synthesizer, E. C. Hutter and others, Radio Corporation of America for Wright Air Development Center, U.S. Air Force, Nov. 1956, may be ordered from OTS, U.S. Department of Commerce, Washington, D.C.

Machine Can Test 2,500 Tubes an Hour

Harrison, N.J.—A new multiple-function tube testing machine which can test up to 2,500 electron tubes per hour has been developed by the RCA Electron Tube Division.

Four of these machines are in use at RCA tube manufacturing centers in Harrison, Cincinnati and Indianapolis. RCA will offer the equipment for sale to other manufacturers of electron tubes.

Each machine can perform up to 15 individual electrical tests on more than 40 miniature receiving tubes per minute. Loading is accomplished by an operator inserting tubes directly into sockets or placing them in an automatic loading device. Unloading is done automatically.

An unusual feature of the factory tube tester is a system of programming that establishes the test criteria for different tube types. Programming boards, containing a maze of spaghetti-like wires, can be plugged into the device in less than a minute. These boards can be pre-set according to the testing schedule and are interchangeable within themselves. A complete change-over from one tube type to another can be made in about 20 minutes.

These testing machines also offer several important advantages for immediate controls in the manufacturing process. For example, mechanical counters register the number of tubes tested, the net of good-tube output, and the quantity and reasons for any rejections. As a result, flaws can be detected promptly and corrective process controls quickly instituted.

The machines pre-heat and then test miniature tubes used for radio, television, and industrial applications.

MARMAN
Engineering Notes

W. M. WILLIS

Present-day supersonic aircraft, ballistic missiles, and nuclear reactors have established environmental conditions that are beyond the capabilities of joint systems utilizing O-rings and conventional gaskets.

Foreseeing this eventuality several years ago, we began the development of an all-metal joint which would exceed the performance of a joint with an organic seal and would maintain a close relationship to the flexible characteristics of organic sealing, while providing top performance under extreme pressures and temperatures. The results of an extensive development and testing program are shown in the Marman Conoseal Joint ad seen at the right.

In addition to the higher temperatures and pressures achieved during testing, it was noted that the clamp V-Band section yielded above proof pressure conditions. However the joint maintained a perfect seal even though flange separation was measured up to .060 inch. This gave us valuable insight into the flexibility of the Conoseal Joint.

Understanding the extreme difficulties of providing a seal between two materials having different coefficients of thermal expansion, tests were continued proving the versatility of the Conoseal for applications involving use of different materials.

Test results prove that the joint will withstand pressures at temperature to the maximum capabilities of the weakest member and still maintain a perfect seal. One flange, for example, fabricated from almost any metal, such as carbon steel, alloy steel, aluminum or stainless steel, and coupled to a flange using any of these variations, will tolerate the substantial difference in thermal expansion.

The basic design concept of the Conoseal lies in the gasket, which is purposely designed to yield within the assembly of two mating flanges. As the rigging load of the clamp is applied on the mating flanges, gasket compresses radially and axially, until the gasket is completely confined and cannot be compressed further.

The results are counterbalanced forces essential in a successful high pressure seal. This unique gasket action does not brinell the flanges; thus the flanges do not require replacement when the joint is disassembled for maintenance purposes.

The Marman Conoseal Joint can withstand thermal cycling within the full extreme ranges of the materials used within the duct system, still maintaining a perfect seal during life expectancy of the unit.

Test reports are available showing the history and development of the Conoseal Joint. The Marman Engineering Department will assist you with your special requirements for fluid systems.

ENGINEERING MANAGER
MARMAN DIVISION, AEROQUIP CORPORATION

MARMAN CONOSEAL Joints Assure Perfect Seal of Dissimilar Metals at Extreme Low Temperatures

Even at extreme cold of —300° F., tubing of dissimilar metals can be joined in a perfect seal by the all-metal CONOSEAL Joint. Seal is maintained through the full temperature range up to red hot 2000° F. (for applicable tubing). Strength and sealing capabilities are also unaffected by distortion, shock or minor linear deflections.

The Marman CONOSEAL Joint assures unlimited shelf life because it is made entirely of metals not subject to deterioration. Its compact design requires minimum envelope clearance; single bolt fastening simplifies installation. Recommended for a wide range of fluids, including liquid metals, the CONOSEAL Joint is available in four weight/strength configurations. Mail coupon below for complete new catalog.

CONOSEAL is an Aeroquip Trademark.

Marman CONOSEAL Joints are available in four operating performance ranges. Standard sizes from 1" to 12" O.D. tube size. Special sizes available.

Joint Type	Temp. Range (°F.)	Max. Pressure (3" size 70°F.)
Lightweight	—300 to +1250	1200 psig
Light Duty	—300 to + 750	1500 psig
Medium Duty	—300 to +1250	3300 psig
Heavy Duty	—300 to +2000	6000 psig

MARMAN DIVISION

Aeroquip Corporation

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11214 Exposition Blvd., Los Angeles 64, California

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to__________°, pressures from__________psi. to__________psi.
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"100 Million Habitable Planets in Universe"

by George Rhodes
Special m/r Correspondent

BERKELEY, CALIF.—It is within "the realm of possibility that man should be able to change the course of the orbit of the moon" some day, a University of California professor of chemistry, associated with its famed Radiation Laboratory, has written in a biochemical study prepared under sponsorship of the Atomic Energy Commission.

Dr. Melvin Calvin's study is titled "Round Trip From Space." Most likely it will be "must" reading for every scientist connected with the space programs of the United States and other nations. It states most clearly the reasons why man must venture into space. And, of course, it should provide Congress with the answers to the question:

"Why should the government finance a space exploration program on non-military grounds?"

There will be, no doubt, many Congressmen—and millions of citizens—who will scoff at Dr. Calvin's study. But men of science everywhere, their students and those with the ability to think beyond their everyday lives, will recognize the significance of his conclusions, based on biological and chemical formulae.

In his concluding chapter, titled "Man In Space—The Next Step," Dr. Calvin declares that:

"Now that man has the capability of taking his machines and himself off of the surface of the earth and of beginning to explore outer space, there is no reason to suppose that life, and man as its representative, will not transform any planet, or any other astral body upon which he lands, in the same way, and perhaps even in a more profound way, than he has transformed the surface of the earth."

- **Habitable planets**—Dr. Calvin concludes from his studies and those of other eminent scientists that there are, conservatively, 100 million "habitable planets to be found in the universe" roughly one in every thousand of the estimated number of planets "which are the correct size . . . which will have the proper atmosphere containing carbon hydrogen, nitrogen and oxygen" . . . and which most likely will have "cellular life as we know it on earth."

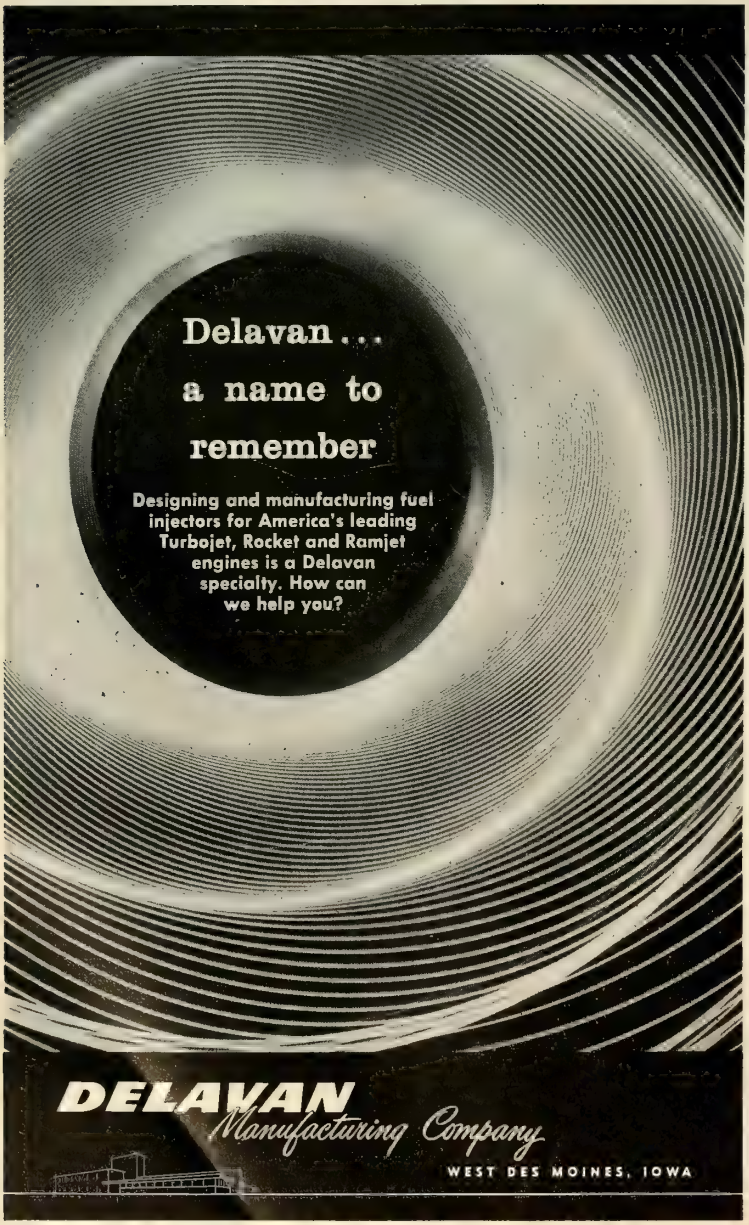
The UC scientist's calculations are limited to those planets which will have conditions within the range compatible with cellular life, based on carbon, as we know it on earth.

"This does not include such systems, which conceivably we can imagine, based on other elements, such as silicon, or nitrogen, or perhaps even anti-matter. Such worlds and such systems may very well exist," Dr. Calvin says, although he does not include these as possibilities in his calculations.

"Since in the course of the chemical and biotic evolution the appearance of man on the surface of the earth has occupied only a very small fragment of time, namely, only one million years of the five billion, it is clear that we may expect to find cellular life, and perhaps precellular life and posthuman life, in many of these other planets."

What better reason can this nation—and preferably every nation on earth in unprecedented cooperation—have for supporting exploration of space?

One can even visualize the time when some eminent editor will say—not "Go West, Young Man" but "Go Out, Young Man."


Delavan . . .
a name to
remember

Designing and manufacturing fuel injectors for America's leading Turbojet, Rocket and Ramjet engines is a Delavan specialty. How can we help you?

DELAVAN
Manufacturing Company
WEST DES MOINES, IOWA

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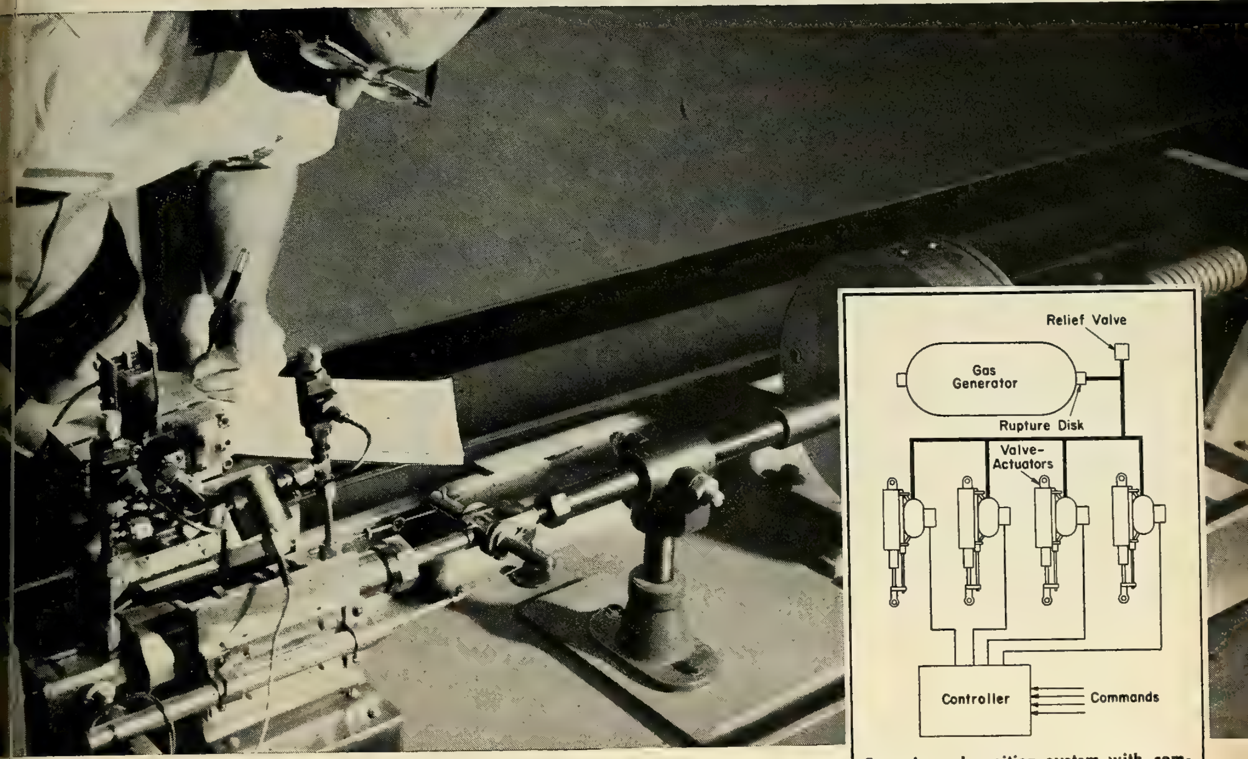
WHERE HYDRAULICS WON'T PERFORM . . .

GAS SERVO SYSTEM



Four-channel position system with common hot-gas generator, designed for thrust-vector control.

Ideal For High Temperature and Radiation Environments, G-E Gas Servos Are Compact—Give Fast Positioning Response

General Electric has developed a new gas servo device for actuation control systems where hydraulic servomechanisms are undesirable. Basically a force servo with position and velocity feedback, it consists of only three major components—an energy source, a valve-actuator unit, and a feedback and stabilization network.

By using the energy directly, rather than converting it to hydraulic power first, the system can tolerate ambient temperatures of 750F and higher. And, by eliminating this energy-conversion step, the number of components is kept at a minimum, simplifying the design, and thus increasing reliability.

As a hot gas servo, a solid propellant is stored in a gas-generating unit that also acts as an accumulator. When ignited, the gases fill the accumulator before entering the pressure-controlled, two-stage servo valve. The bleed-type first stage regulates the pressure in the second stage. This diverts the gas to either side of the actuator to control output force.

As a cold gas servo, with air or an inert gas as the energy source, the same system reduces contamination problems in high nuclear-radiation areas. In addition, the "closed-center" type valve also offers operating economies in such a system, when using stored gas or a closed cycle in which the gas is reused.

This servo system design offers several advantages over other approaches:

1. High frequency response is possible through pressure-type control. For example: 20 cps at 90-degree phase lag, with a 250-pound load. Higher response is possible with increased control bleed flow.
2. The unit is flexible. Damping, stiffness, and accuracy characteristics are controlled electrically. No change in hardware is needed.
3. Poppet valves minimize leakage. They have no close-fitting sliding parts and are well suited for high-temperature operation.
4. Symmetry of design lessens thermal shock problems, minimizes effects of G-forces, and avoids null shifting.

A dry system, the G-E servo eliminates virtually all the problems resulting from the static storage of liquids—thermal expansion, leakage, evaporation, etc. This reduces maintenance and insures instantaneous readiness.

If you'd like more information about G.E.'s gas servo and how it could help simplify your positioning-control designs, just fill out and mail the attached coupon, or contact your nearest General Electric Aviation and Defense Industries Sales Office.

Manufactured by General Electric's Aircraft Accessory Turbine Department, West Lynn, Massachusetts

Progress Is Our Most Important Product

GENERAL ELECTRIC

Section B231-22, General Electric Co.
Schenectady 5, New York

Please send me "Gas Servo System" bulletin, GEA-6846.

☐ Immediate Project ☐ Reference Only

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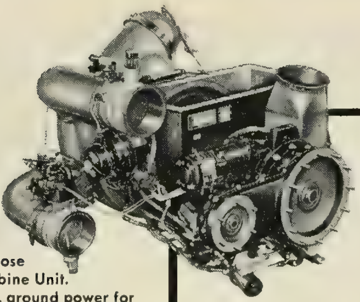
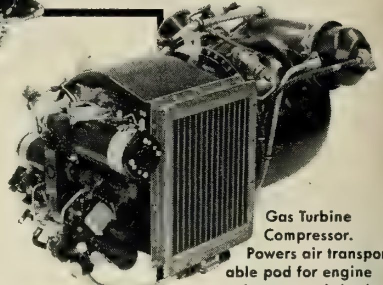
AiResearch gas turbines proved most versatile and reliable...

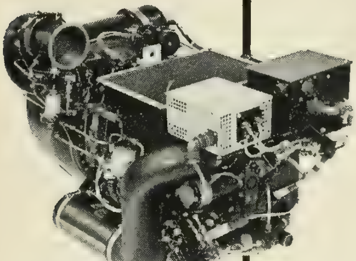


Multipurpose
Gas Turbine Unit.
Airborne, ground power for heating, cooling, starting, electrical, hydraulics, pressurization of military aircraft.

Gas Turbine Power Unit. Aircraft and missile ground support to drive generators, pumps, compressors. Weighs only 45 lbs.

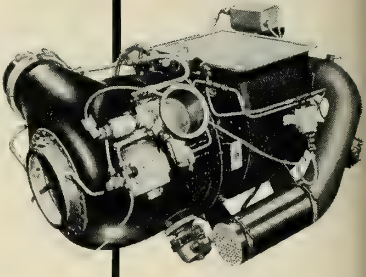


Gas Turbine
Compressor.
Powers air transportable pod for engine starting, ground check-out, ice and snow removal.

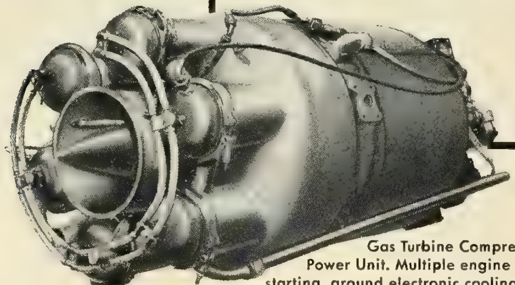


Gas Turbine
Compressor. Standby in-flight pneumatic power for turbine-powered transports.

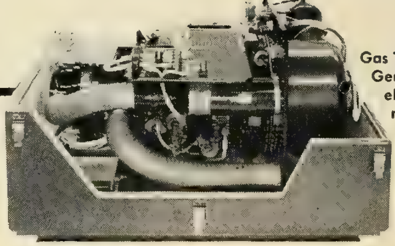
8,000 now in operation



Gas Turbine Compressor Power Unit. Electrical and pneumatic ground power source for jet transports.



Gas Turbine Compressor Power Unit. Multiple engine starting, ground electronic cooling, electrical and hydraulic power, trailer or pod mounted.



Gas Turbine
Generator Set. Primary electrical power for missile launchers, guidance and refrigeration systems.

AiResearch Gas Turbines are used in hundreds of applications: auxiliary power and ground support for missile systems, military and commercial aircraft; main engine starting, electrical and pneumatic power, air conditioning, pressurization, pre-flight checkout, snow and ice removal; prime power for helicopters; variety of ground applications or aboard aircraft for mobile or stationary use.

Advantages: these lightweight units are air transportable as fixed installations, detachable pods or portable vehicles; supply low pressure air and shaft power from 30 H.P. to 850 H.P.; provide variety of electrical power—9 to 150 KW, 60, 400 and 1200 CPS, AC or DC; have highly refined self-regulating controls and operate in any weather; have instant push-button starting; time between overhauls 1000 hours or 3000 starts.

Your inquiries are invited.

ENGINEERING REPRESENTATIVES: AIRSUPPLY AND AERO ENGINEERING, OFFICES IN MAJOR CITIES

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

Circle No. 20 on Subscriber Service Card.

letters

APS Roundup Enjoyed

To the Editor:

I have just finished reading with great interest the article entitled "Auxiliary Power Systems Challenge Chemicals" by Associate Editor Peer Fossen, which appeared in the November 3 issue of m/r.

My only objection or criticism to your most excellent presentation is the use of the word "Hydrox" in conjunction with fuel cells. "Hydrox Fuel Cells" is a trademark of the Universal Winding Co.

Anthony M. Moos
Vice President and General Manager
Patterson, Moos Div. of Universal
Winding Co., Inc.

Dream and Convictions

To the Editor:

When a dream becomes a conviction in the minds of scientists who are dedicated to the evolution of ideas and who possess the perseverance to stick with their convictions, success is imminent. But ultimate success does not come easy for those trodding the rocky road of evolutionary development.

Modern research scientists face heavy demands on their courage and determination—for inaction and delay sprout in every filing cabinet and blossom in every staff conference. If these stumbling blocks are not sufficient deterrents to success there are other detours in the form of bureaucratic red tape, the two year Congressional turnover and re-education job, sudden budgetary cuts and restrictions being placed on programs well underway, and mass media attacks against which there is little recourse.

Every layman has access to the serious lessons of history, but the basic research scientist is not so richly endowed, for he is the pioneer of each decade, each generation, and each century. He must travel the road of totally unknown but assumed probabilities. He must weave the tedious pattern of trial and error to prove or disprove his convictions.

His dedication to progress often forces him into a lonely existence or he may drop over the precipice into oblivion because of his willingness to take the calculated risk.

Massive successes and massive errors make good reading and sell newspapers. But the lonely hours of research, intense pressure from the un-

HERE'S THE SECOND BEST WAY TO TAKE A MISSILE'S TEMPERATURE

This self-balancing potentiometer is not quite as accurate as the best laboratory equipment.

However, it is very accurate. It is also very light, very rugged and very reliable. It can operate from any type of thermocouple. It contains its own cold junction compensator and a highly stable reference voltage, so its accuracy is virtually unaffected by ambient conditions.

It can provide a voltage output for telemetering, or a direct indication in degrees Fahrenheit or Centigrade for on-the-ground monitoring. In either case, performance is unaffected by length or resistance of leads. If required, snap action switches can be included for over-temperature warning, or to control other equipment.

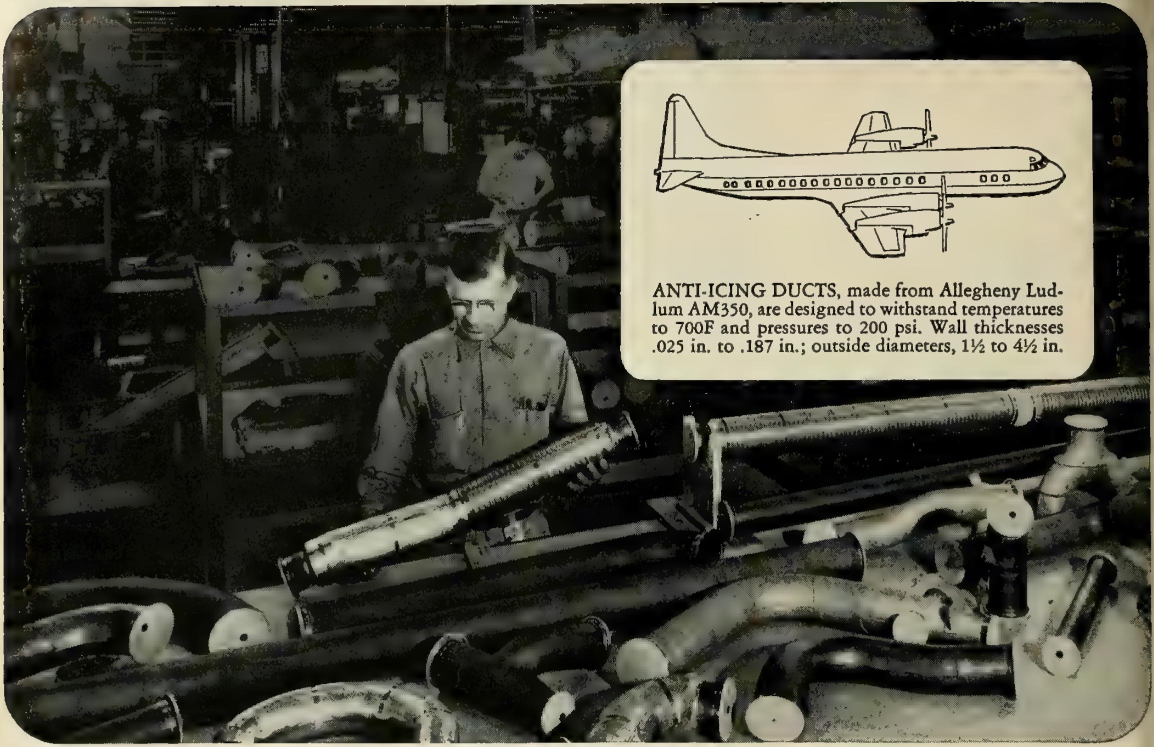
The Avien Self-Balancing Potentiometer is just one* of the versatile building blocks in Avien's integrated system concept of temperature measurement and control instrumentation. Complete technical data and application information can be had by writing for Bulletin D134. Avien, Inc., 58-15 Northern Blvd., Woodside 77, N.Y.

*Other Avien products for temperature measurement and control include
RESISTANCE BRIDGES • MAXIMIZING-MINIMIZING SYSTEMS • MULTI-CHANNEL MONITORS
LIMIT DETECTORS • COLD JUNCTION COMPENSATORS • REFERENCE VOLTAGE SUPPLIES

Avien WOODSIDE 77 • NEW YORK
Precision Instruments and Control Systems

Circle No. 37 on Subscriber Service Card.

Experience—*the extra alloy in* **Allegheny Stainless**



ANTI-ICING DUCTS, made from Allegheny Ludlum AM350, are designed to withstand temperatures to 700F and pressures to 200 psi. Wall thicknesses .025 in. to .187 in.; outside diameters, 1½ to 4½ in.

made from Allegheny Ludlum precipitation-hardening stainless:

Prop-jet's anti-icing ducts take high heat and pressure in stride

The anti-icing system of a new prop-jet airliner was designed to operate under high heat and pressure, yet the ducting had to be as light as possible. AM350 was specified. Both AM350 and AM355, Allegheny Ludlum's precipitation-hardening stainless steels, have strength/weight ratios at 600F five times greater than the usual aluminum aircraft alloy. In fact, AM350 and AM355 maintain high strength from room temperature up to 1000F.

These space age metals have other properties highly desirable: excellent corrosion resistance, ease of fabrication, low temperature heat treatment, good resistance to stress corrosion.

These features have been used to advantage in airframe structural members, airframe skins, pressure tanks, power plant components, high pressure ducting, nacelles and other missile and supersonic aircraft applications.

availability: AM350, introduced several years ago, is available commercially in sheet, strip, foil, small bars and wire. AM355, best suited for heavier sections, is available commercially in forgings, forging billets, plates, bars and wire.

corrosion resistance: Compared to the more familiar stainless grades, AM350 and AM355 resist corrosion and oxidation better than the hardenable grades (chromium martensitic) and only slightly less than the 18 and 8's. They resist stress corrosion at much higher strength levels than do martensitic stainless grades.

simple heat treatment: High strength is developed by two methods. Both minimize oxidation and distortion problems. The usual is the Allegheny Ludlum-developed sub-zero cooling and tempering (SCT): minus 100F for 3 hrs plus 3 hrs at 850F. Alternate method is Double Aged (DA): 2 hrs at 1375F plus 2 hrs at 850F.

easy fabrication: AM350 and AM355 can be spun, drawn, formed, machined and welded using normal stainless procedures. In the hardened conditions, some forming may be done . . . 180 degree bend over a 3T radius pin. Also AM350 can be dimpled in the SCT condition to insure accurate fit-up.

For further information, see your A-L sales engineer or write for the booklet "Engineering Properties, AM350 and AM355." *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.* Address Dept. MR-12.

WSW 7341

ALLEGHENY LUDLUM

EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

Circle No. 19 on Subscriber Service Card.

initiated, and necessary preoccupation with the task at hand are not so well known to the reading public. Nonetheless, the intermediate sucesses and failures, unglamorous though they be, are the stable mates and pacers for the eventual Derby winner.

The indomitable spirit of the research scientists made of "blood, sweat, and tears." When this high courage of the inner human soul takes over, genius is distinguished from mediocrity. The destiny of success is never automatic with any individual or group regardless of the awesome array of talent—the ingredients of courage and determination must be at hand and in use. The scientists who survive through the unwarranted milieu besetting them truly become the scientific giants of the age and should so be recognized.

Robert A. Smith III
Redstone Arsenal
Huntsville, Ala.

Acoustica Included

To the Editor:

We would like to call your attention to an omission in the "Missile Prime Contracts List" on page 12 of your Nov. 17 issue.

Acoustica Associates, Inc. of Mineola, New York and Los Angeles, Calif. is a prime contractor on the *Atlas* missile program. You did not list our company and we hope you can correct this error in your forthcoming issues.

Just under two years ago, Acoustica received a research and development contract approaching $1-million from the U.S. Air Force Ballistic Missile Division, involving a system for controlling the flow of liquid propellants to the engines in the *Atlas*. More recently, the Air Force awarded the company substantial production contracts for airborne equipment and related ground support equipment and services.

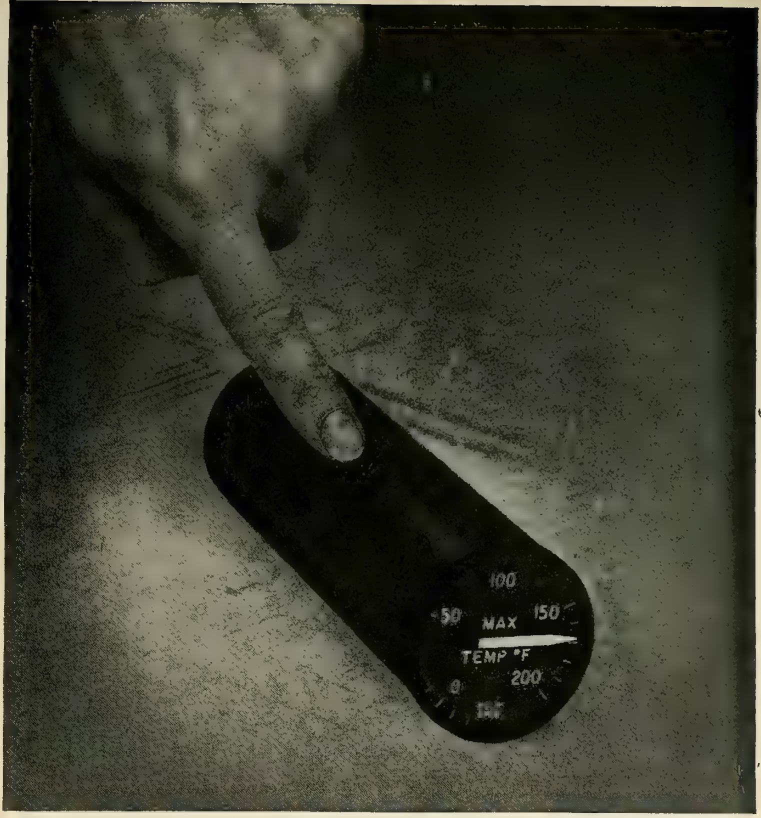
Ralph Reynolds
Vice President,
Acoustica Associates, Inc.
Mineola, NY

No Russian Failures

To the Editor:

Recently I attended a meeting of the Institute of Petroleum in London at which a member of the Soviet Embassy staff read a paper on "Soviet Earth Satellites."

As expected, this contained little that was new to astronautics experts, admirable as it was for the type of audience concerned. However, there was one interesting point made. The Soviet engineer categorically stated



THIS TEMPERATURE BRIDGE IS LOOKING FOR TROUBLE

Avien's Maximizing-Minimizing Temperature Bridge monitors any number of temperatures, at any number of locations. But it does more than that. It picks out the worst condition, presents a precise indication of its magnitude. As a result you can keep an eye on possible trouble spots without the need for multiple indicators.

It does this job automatically and continuously, without relays, mechanical linkages or memory circuits. It operates from any type of resistance bulb or thermistor sensor, over any range of temperatures. It can signal when any temperature is over limits—or operate valves, pumps, refrigerating systems and other equipment.

It can provide an analog voltage output for telemetering or a direct indication in degrees Centigrade or Fahrenheit for on-the-ground monitoring. It is very accurate, very rugged and very light.

The Avien Maximizing-Minimizing Bridge can be used by itself as a multichannel monitor, or with other Avien temperature instrumentation* as part of a complete measurement, supervision and control system. Full technical data and application information can be had by writing for Bulletin D135. Avien, Inc., 58-15 Northern Blvd., Woodside 77, N.Y.

*Other Avien products for temperature measurement and control include
TEMPERATURE ANALYZERS • SELF-BALANCING POTENTIOMETERS • RESISTANCE BRIDGES
LIMIT DETECTORS • COLD JUNCTION COMPENSATORS • REFERENCE VOLTAGE SOURCES

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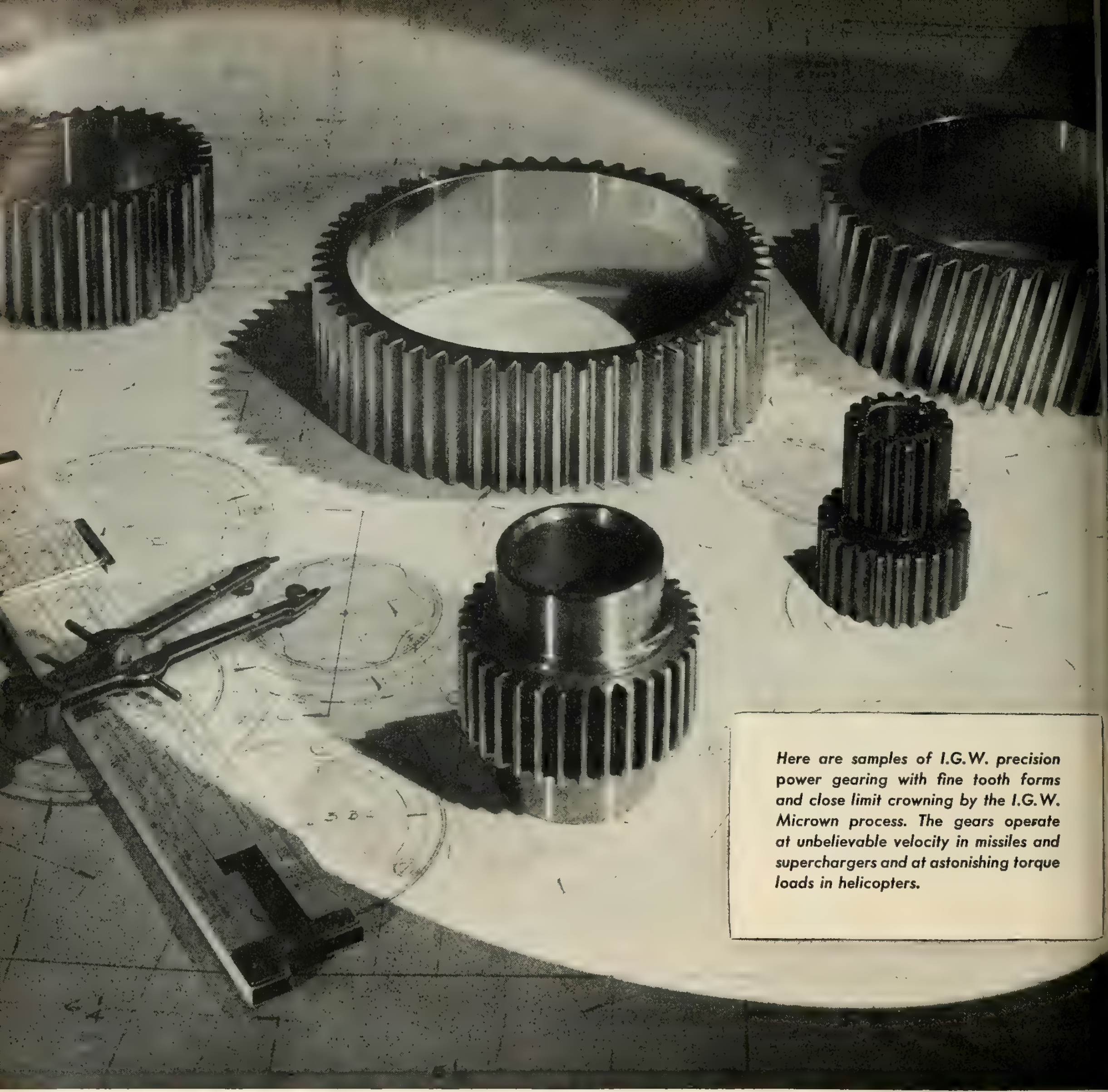
Precision Instruments and Control Systems

Circle No. 38 on Subscriber Service Card.



Here are samples of I.G.W. precision power gearing with fine tooth forms and close limit crowning by the I.G.W. Micrown process. The gears operate at unbelievable velocity in missiles and superchargers and at astonishing torque loads in helicopters.

missile precision

is our kind of precision

- Exacting tolerances—tight schedules—they're all in a day's work at I.G.W. Day after day, year after year, our experience in the missile and aircraft field enables us to put teeth in the word precision—and precision into teeth.

IGW

INDIANA GEAR WORKS, INC.
INDIANAPOLIS 7, INDIANA

that there were no unsuccessful attemps to launch artificial earth satellites in Russia.

After his lecture, I asked him why, if this was the case, the USSR had not sent up more satellites, since they appeared to have the equipment available and there were many more measurements to be made. He answered by saying that Sputnik III was still in orbit and carrying out its task, so it was not necessary to send up other satellites.

"Does this mean that the next Russian satellite will be yet another design?" is a question that prompts itself to us.

The speaker gave the estimated life of Sputnik III as over 500 days. He said Russia had solved the re-entry problem, and that teams of Soviet scientists were working on advanced propulsion systems such as nuclear engines with liquid hydrogen as a working fluid, ion rockets, and photon rockets.

"These seem fantastic proposals today," he said, "but what would you have thought if I had come here a year ago (before Sputnik I) and given this lecture?"

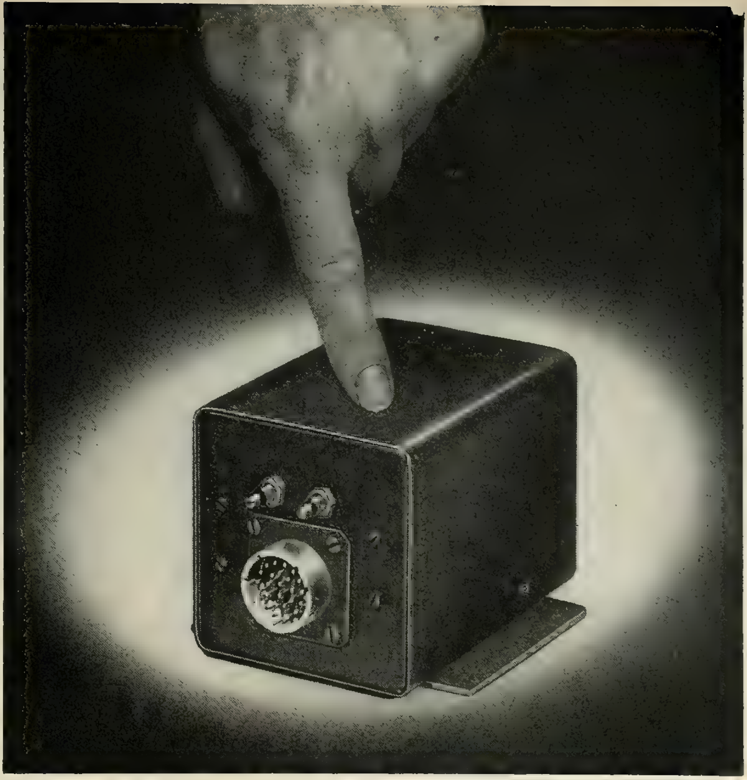
G. V. E. Thompson
Editor, Journal of the British
Interplanetary Society

Space Dictionary

To the Editor:

There are many highly technical terms used in the missile industry today. Often a person will use one of these terms without clearly understanding its meaning. For this reason several such terms are defined below, so that there will be no further confusion when the subject of missiles is under discussion:

Missile: As good as a mile.
Rocket: (1) Precision dancer at a New York theater. (2) a confidence game. (3) Much noise.
Fuel: What you can do to all of the people some of the time.
Solid State: Condition of being real gone.
Semi-conductor: Part-time streetcar jockey.
Reactors: Concerning thespians.
Filter: Touched her.
Anode: Ann knowed!
Address: Ladies' garment (singular).
Armed: Cockney expression meaning "hurt."
Beacon: Meat often served with eggs.
Breeding: Inhaling and exhaling.
Mode: Cut the grass.
Cross modulation: Modulation that is annoyed.



HOW TO TELL WHEN A MISSILE IS "READY"—AT 1200 MPH

This little black box tells flight crews when an airborne missile can go—or when it must be held back to avoid a costly misfire.

Now specified for one of the USAF's major weapon systems, the Avien Signal Comparator is designed to recognize—and act upon—minute variations in AC or DC voltage levels. It can monitor two or more signals simultaneously, triggers action only when all are within tolerance.

Built for rugged airborne duty, it performs dependably even in the presence of acoustical noise up to 150 db. Its high impedance floating input prevents loading signal circuits, eliminates effects of ground loops. Where required a built-in reference makes operation independent of external measuring equipment.

Like all Avien instrument and control systems* the Signal Comparator is designed for application flexibility. It makes a dependable go/no-go comparator, out-of-limit detector or sequence actuator for any application —airborne or ground—where positive control from a critical signal is mandatory. Complete technical data and application information can be had by writing for Bulletin D137. Avien, Inc., 58-15 Northern Blvd., Woodside 77, N.Y.

*Other Avien products for missile instrumentation and control include
RESISTANCE BRIDGES • MAXIMIZING-MINIMIZING MONITORS • MULTI-PARAMETER MONITORS
SELF-BALANCING POTENTIOMETERS • COLD JUNCTION COMPENSATORS
REFERENCE VOLTAGE SUPPLIES

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Circle No. 39 on Subscriber Service Card.

← Circle No. 15 on Subscriber Service Card.

To a man floating weightless around Space Station C, these are perhaps meaningless words—but *solid footing* is highly important to most of us who live and work on the surface of the earth.

Autonetics has established a solid footing in inertial guidance through 12 years of successful development and production of airborne and ocean-going systems, as well as systems for space applications.

The healthy growth of the Autonetics Guidance Engineering department—based on a number of highly diversified contracts—has created new senior-level positions in the fields of electro-mechanical component development and system analysis.

Well qualified, experienced men will find solid footing in this permanent, progressive, and successful organization—plus the chance to create and to grow in one of today's most challenging fields.

But time's a-wasting. *Now* is the time to find out what the future holds for *you* at Autonetics.

Please send your resume to Mr. N. M. Benning, Manager, Employment Services, 9150 E. Imperial Highway, Downey, California.

NERVE CENTER OF THE NEW INDUSTRIAL ERA **Autonetics**
A DIVISION OF NORTH AMERICAN AVIATION, INC.

Element: A pachyderm.
Feed: Pedal extremities.
Fission: Angling, trolling, casting.
Impact: Act of an imp.
Launcher: One who eats a midday meal.
Jam: Precious stone.
Phase: Front of the head.
Wake: Seven days in Ireland.

Harold S. Sharp, Chief Librarian
ITT Laboratories
Fort Wayne 1, Indiana

. . . *Ed.*
These days, a laugh is worth a lot.

Concerning a "Goof"

To the Editor:

Knowing the m/r staff as rocket experts, I was surprised to see in your article, "About *Pioneer*" (m/r, Nov. 3, p. 11) a "goof."

All previous releases on the second stage power plant of the *Vanguard* gave the thrust as 7,500 pounds; however, in your article I see it has been "jazzed up" to 20,000 pounds of thrust.

R. J. Hughes
1476 Dordine Lane
Cincinnati 31, Ohio

When we "goof," we really "goof."
. . . *Ed.*

Splitting the Inch

To the Editor:

We read with a great deal of interest your fine article "Precise Measurements Sought for Space," which appeared in the October 27 issue, but disagree with your statement that "gyros have become so precise that they are designed to be built with more accuracy than any available laboratory measuring instrument."

Since our business is one of "splitting the inch finer and finer" through design and manufacture of precision measuring instruments, we have commercially available both apparatus and standard measuring facilities, with capabilities well above the tolerances specified on missile guidance components.

On the matter of facilities, we were the first company in the U.S. to establish, with the blessing of the U.S. Bureau of Standards, a measurement laboratory combining the finest features of standards laboratories throughout the world.

Carl J. Linxweiler
Director of Public Relations
The Sheffield Corp. of
Bendix Aviation Corp.
Dayton, Ohio

HOW TO SEE WHAT'S COOKING IN A HOT MISSILE

This multi-channel temperature analyzer continuously samples temperatures at 32 different locations and indicates their magnitudes simultaneously on a 'scope screen. One glance and you have the whole temperature picture.

Temperatures at all locations are monitored with respect to each other, and at the same time, with respect to an internal reference. A built-in comparator measures temperatures at any location rapidly and precisely, without interrupting the display, and without the use of auxiliary equipment.

The Avien Multi-Channel Temperature Analyzer can operate with any type of thermocouple, over any temperature range. It contains its own cold junction compensator, so accuracy is unaffected by ambient conditions. Its companion scanner-amplifier may be located anywhere, so only short thermocouple runs are required.

Like all Avien temperature instrumentation* it is very accurate. It is also very versatile. For particular requirements it can be supplied in models to accommodate any desired number of data channels—and to monitor vibration, flow, pressure, voltage and most other parameters.

Complete technical data and application information may be had by writing for Bulletin D136. Avien, Inc., 58-15 Northern Blvd., Woodside 77, N.Y.

*Other Avien products for temperature measurement and control include
RESISTANCE BRIDGES • SELF-BALANCING POTENTIOMETERS • MAXIMIZING-MINIMIZING BRIDGES
COLD JUNCTION COMPENSATORS • REFERENCE VOLTAGE SOURCES

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Precision Instruments and Control Systems

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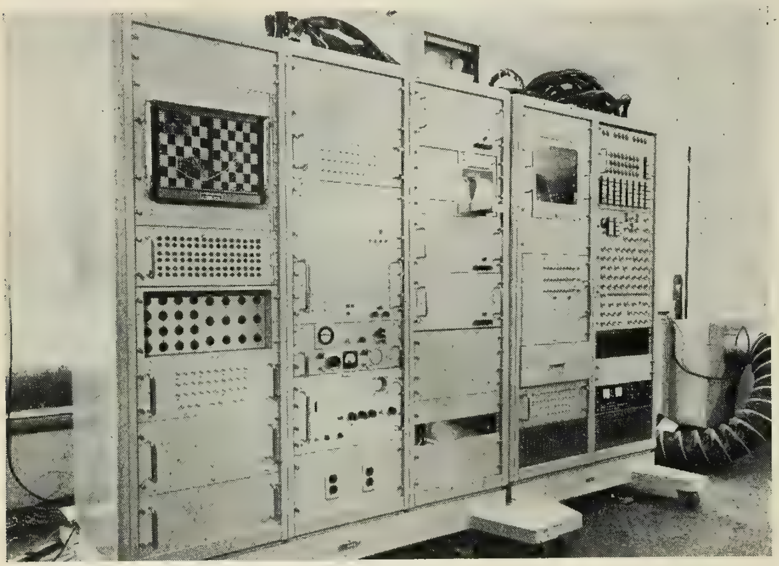
Missile Automatic Checkout Units Available



Systron Corporation has just completed two automatic checkout units for missiles and now offers as a standard production unit a complete universal automatic tester capable of rapidly evaluating, within assigned limits, dynamic functional capabilities of a weapon system, sub-system, or components without manual surveillance.

The space system provides for automatic IBM card programming and will accept 1000 inputs from any electronic sub-assembly. The unit provides complete printed record, precision limit detection, in-line nixie readout and removable patchboard for control logic and switching of stimuli to the unit under test.

The principal feature of this new equipment is the precision it provides in evaluating such inputs as DC voltages, true RMS of AC voltages, peak-to-peak of AC voltage, resistance, frequency, time interval, or periods from the unit under test. Because of the flexibility provided by the IBM card programming and patchboard, the system can be adapted to any electronic assembly, even though designed specifically for checkout of missile electronic sub-assemblies.

The system was designed to meet many military specifications and provides for internal standards, manual or automatic control, visual monitoring, digital selection of sampling rate, and self-check and verification. The heart of the system is the universal digitizer and limit comparator designed by **Systron Corporation** specifically for this system.

Circle No. 225 on Subscriber Service Card.

RCA Introducing Air-cooled Beam Tubes

Two new, very small and compact, forced-air-cooled beam power tubes (RCA-7203/4CX250B and RCA-7204/4X250F) designed with ceramic-metal seals throughout have been introduced by the **RCA Electron Tube Division.**

Capable of dissipating 250 watts in the plate, each of the new types is useful as an audio-frequency power amplifier and modulator, as a wide-band amplifier in video applications, as a linear radio-frequency power amplifier in single-sideband suppressed-carrier equipment, and as a class C amplifier and oscillator. The tubes can be operated with full ratings at frequencies up to 500 megacycles.

The maximum plate-dissipation rating of 250 watts is made possible without sacrifice in tube reliability by the specially designed, high-efficiency radiator which is brased directly to the plate for better heat transfer.

Both types are identical except for their heater ratings. The 7203/4CX250B has a 6-volt, 2.6-ampere heater as compared with a 26.5-volt, 0.58-ampere heater in the 7204/4X250F.

Circle No. 229 on Subscriber Service Card.

Transient Filters Eliminate Switching Use

E.R.A. Electric Corp. is producing a new line of transient filters which are intended for switching applications. The "Slim Tran" transient filters are connected to the DC input of the transistor circuitry and eliminate hash and noise transmission to the external circuitry, as well as protecting the switching transistors against line conducted transients. These filter components are designed for all types of transistor inverters, converters, frequency changers, and semi-conducted switching circuits.

Slim Tran units have low loss inductive elements and high Q capacitors. Stock units are available for center keying frequencies of 60, 400, 2,000, and 5,000 cycles. DC ratings extend up to 5 amp. DC resistivity is a few tenths of an ohm and attenuation for unwanted components is in excess of 50 DB. A typical filter size is 1 x 1 x 1½ inches and weight is three ounces.

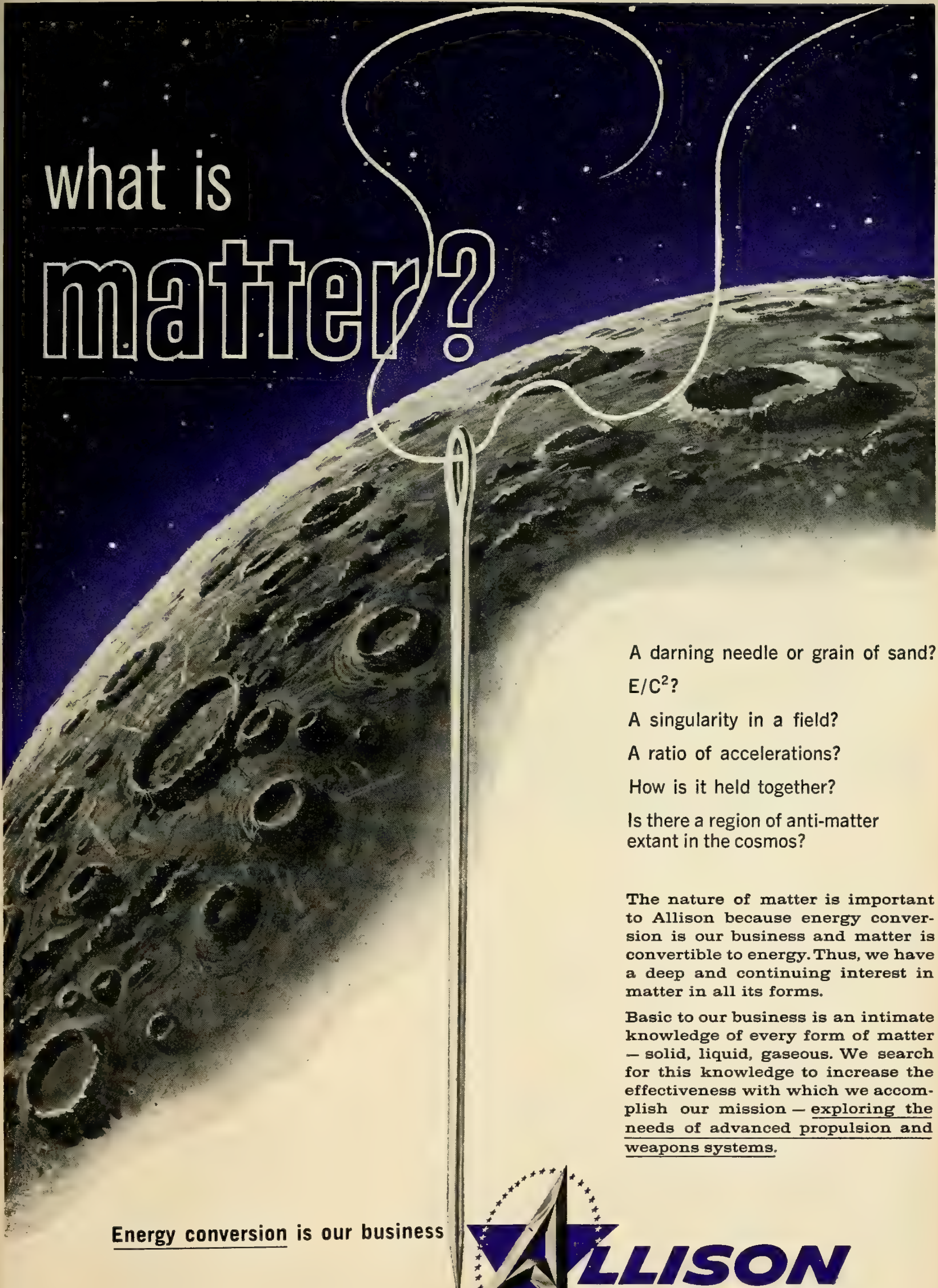
In addition to stock designs, special designs are also available in modified ratings for both commercial and military applications.

Circle No. 250 on Subscriber Service Card.

NOTE: *For additional information about any product mentioned in this section of Missiles and Rockets use the attached prepaid reply cards. Circle numbers shown on the reply card that correspond with numbers appearing beneath items described. If no circle number accompanies the article or advertisement, give page number (and advertiser's name) on line provided at bottom of the card.*

Your requests for information will be forwarded promptly to the companies concerned.

The Editor



A darning needle or grain of sand?

E/C^2?

A singularity in a field?

A ratio of accelerations?

How is it held together?

Is there a region of anti-matter extant in the cosmos?

The nature of matter is important to Allison because energy conversion is our business and matter is convertible to energy. Thus, we have a deep and continuing interest in matter in all its forms.

Basic to our business is an intimate knowledge of every form of matter — solid, liquid, gaseous. We search for this knowledge to increase the effectiveness with which we accomplish our mission — exploring the needs of advanced propulsion and weapons systems.

Energy conversion is our business

ALLISON

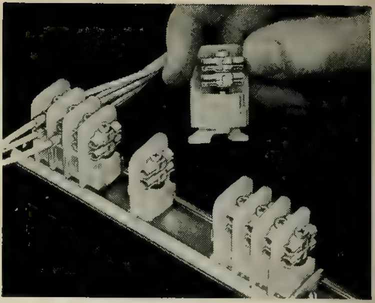
Division of General Motors,
Indianapolis, Indiana

New Terminal Block Marketed by Burndy

Based on the modular principle, Modulok, a new, extremely versatile and reliable terminal block accommodating wire sizes #22-#12, is now available from the **Omaton Division of the Burndy Corporation,** Norwalk, Conn.

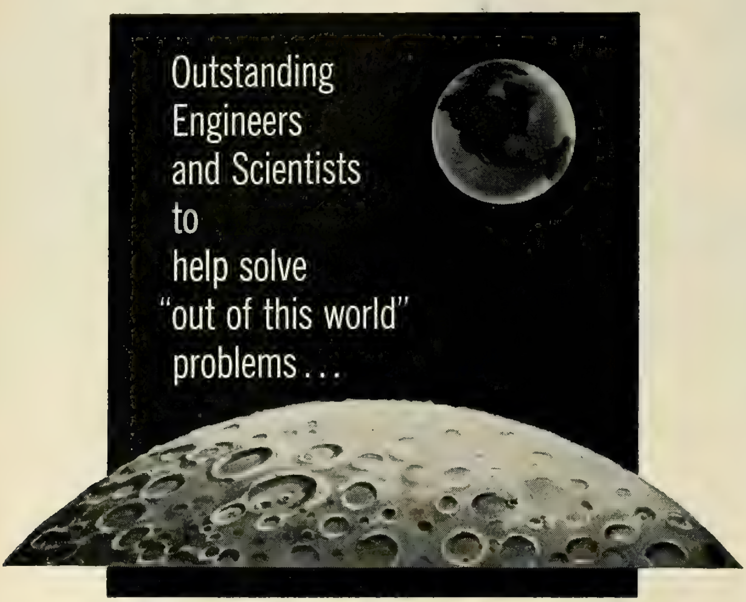
Modular construction allows individual modules to be snapped together or apart and then inserted onto a steel track and locked by end locks. The modules are made of Zytel 31, a nylon compound having extremely low water absorption characteristics. The tracks are available in any lengths up to 32 inches and 30 modules may be mounted per foot of track.

Modules have either 2 or 4-tier spring-loaded plated sockets which may be set for quick-disconnect for rapid ring-out, bussing, or circuit changes. A twist of a screwdriver transforms the quick-disconnect into a permanent connection. These unusual spring-loaded sockets exert continuous and uniform pressure in either position.



Solderless crimp-type contact tips installed on wire ends are inserted into the sockets and provide high reliability and speed of assembly as contrasted to the high rejection rate and slow assembly characteristic of solder operations.

Circle No. 231 on Subscriber Service Card.



Today artificial satellites orbit in space. Missiles can span continents. Conservative scientists calmly talk of landing on the moon.

Just as they have contributed to other aeronautical sciences, the various divisions of United Aircraft Corporation have made significant contributions to these new fields of missiles and space technology.

Recently the outstanding scientists and engineers who had specialized in missiles, missile guidance and space penetration problems in each division were brought together to focus their combined skills on advanced concepts and systems. A new Division was created . . . the Missiles & Space Systems Division.

This division is only weeks old. It is in an explosive growth period. Yet it has a built-in stability factor . . . the advantages of the brainpower, the "know-how", the financial resources and the unique facilities of a billion-dollar corporation that is already preeminent in aeronautics.

This combination of newness and stability should be significant to every alert engineer or scientist. It should suggest a unique opportunity to demonstrate ability and win the advancement and other rewards that ability deserves.

If you are looking for opportunity, we suggest that you contact us immediately.

Positions are available at all levels in . . .

ELECTRONICS: Guidance, Radar, Countermeasures, Computers, Telemetry • SYSTEMS ANALYSIS • SYSTEMS INTEGRATION • MILITARY REQUIREMENTS • RELIABILITY • GROUND SUPPORT • SPACE TECHNOLOGY: Astrophysics, Astronautics • AERONAUTICS: Preliminary Design, Performance, Aerodynamics, Structures, Propulsion.

Please send your complete resume, including salary requirements, to Mr. John B. North.

MISSILES & SPACE SYSTEMS DIVISION
UNITED AIRCRAFT CORPORATION • EAST HARTFORD 8, CONNECTICUT

Ceramic Coil Form Available for Circuitry

Cambridge Thermionic Corporation has added a new ceramic coil form for printed circuitry to its line of Cambion (R) coil forms.

This new ceramic coil form permits primary and secondary windings on a single form with each winding independently tunable. The form is internally threaded to accept threaded powdered iron tuning cores supplied for four different frequency ranges (2-1.5 mc, 1-20 mc, 20-50 mc, and 30-150 mc). Unshielded and designed for horizontal mounting, its overall length is 1.328". This new coil form is Grade L-5 silicone impregnated ceramic with silver plated brass terminals mounted on fiberglas collars.

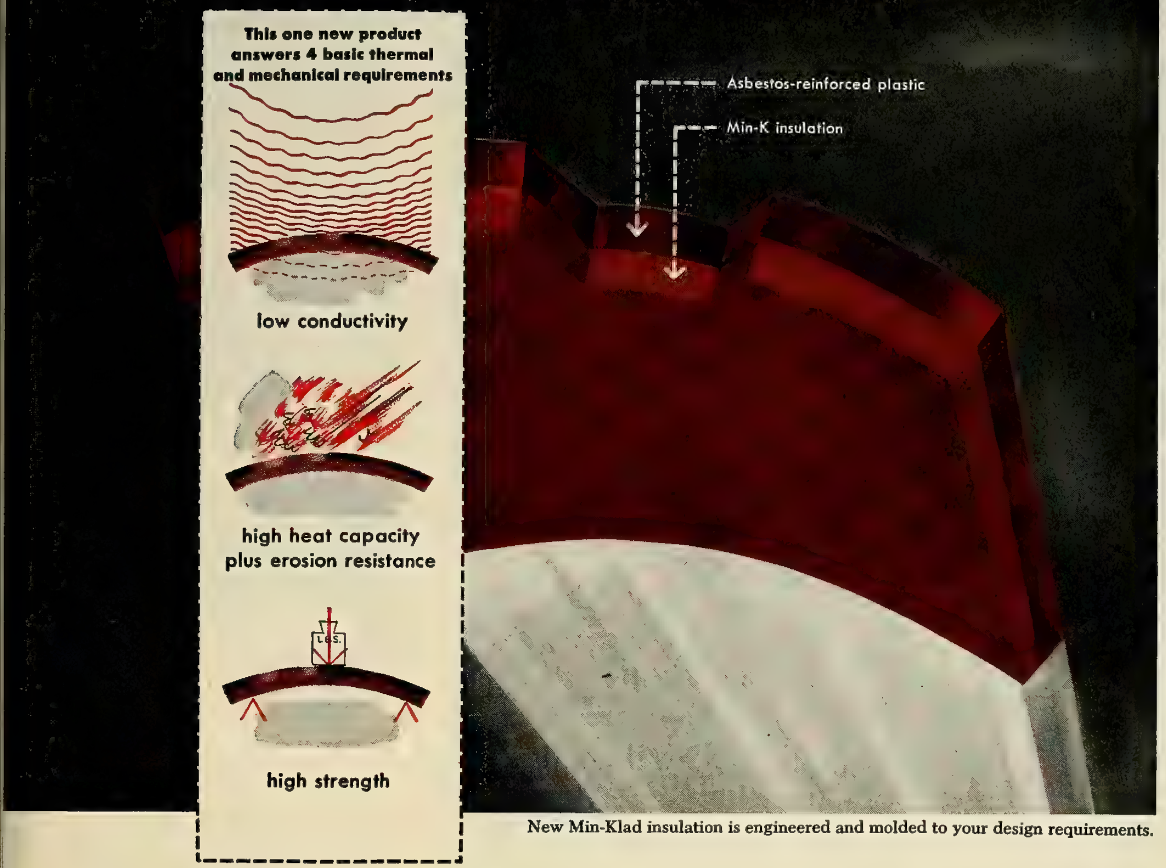
Circle No. 226 on Subscriber Service Card.

2.5 oz. Servomotor Available from Beckman

Four major servo-design requirements are met by the newest Size 8 rotating component introduced by **Helipot Division of Beckman Instruments, Inc.,** the Beckman Inertia-Damped Servomotor Model 8 IM 460.

This new servomotor is small enough (2.5 ounces, 1.680" long) to be

Johns-Manville announces new **MIN-KLAD** Insulation!


This one new product answers 4 basic thermal and mechanical requirements
low conductivity
high heat capacity plus erosion resistance
LBS.
high strength
Asbestos-reinforced plastic
Min-K insulation

New Min-Klad insulation is engineered and molded to your design requirements.

Combines the capabilities of asbestos-reinforced plastic with the dramatically low conductivity of MIN-K insulation!

New Min-Klad insulation may well be the most significant advance ever made in missile and rocket insulation.

Developed by Johns-Manville research scientists, Min-Klad is the only product of its kind, a permanent lamination of the missile industry's two most effective high-temperature materials: 1) reinforced plastic and 2) J-M's recently developed Min-K insulation.

Does more than plastic alone

Min-Klad gives the missile designer all the advantages of high-temperature plastic: Strength, toughness, rigidity! Erosion resistance! High heat capacity! Yet Min-Klad does more.

It also insulates . . . and with dramatic effectiveness! Its insulating element is J-M's Min-K, an insulation with thermal conductivity that is lower than any other known insulation. Actually lower than the molecular conductivity of still air. And this conductivity (already less than half that of the best fibrous insulations) drops still further with altitude. At 10 miles, for example, it is decreased by as much as 40%, with further decreases at greater altitudes.

Wide range of applications

Min-Klad offers the missile and rocket designer a rich choice of heat-control possibilities. It may be used for a part that must insulate, yet have the structural advantages of plastic. Where requirements call for a scuff- and erosion-resistant insulating surface . . . or for a good adhesive bond between Min-K insulation and other surfaces. Or, it may be used to control high transient temperatures! For high heat capacity of asbestos-reinforced plastic combined with the low conductivity and heat capacity of Min-K result in a product that provides minimum heat transfer under transient conditions.

Min-Klad is now being tested for approximately two dozen missile and rocket designs. Why not investigate this new material for your present thermal requirements? Upon request, we'll be pleased to send you a sample of the material along with detailed technical information. Write Johns-Manville, Box 14, New York 16, New York. (Ask, too, for information on Min-K insulation and the new aviation insulation brochure IN-185A.) In Canada: Port Credit, Ontario.

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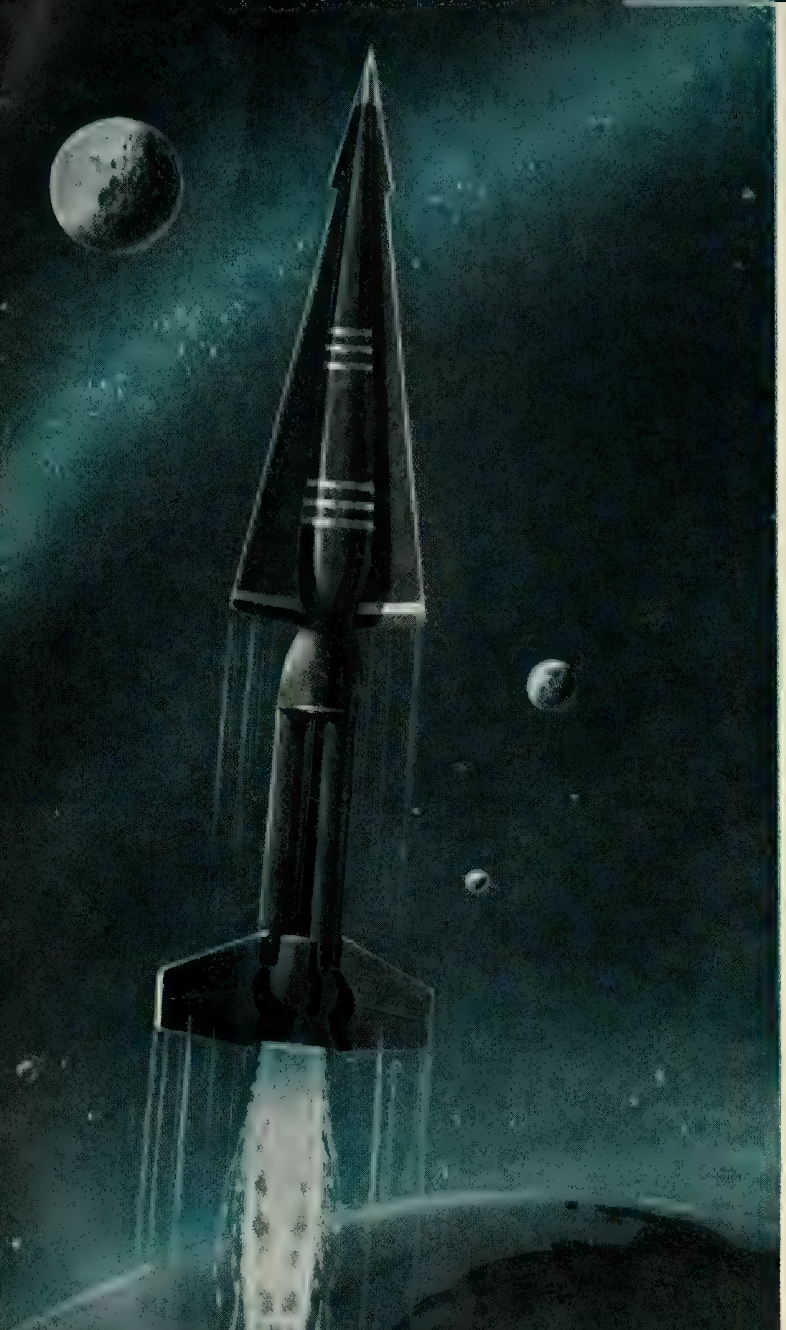

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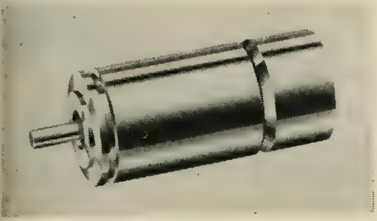
used in subminiature systems. It will operate from a 115-volt, 400-cycle source. Acceleration and deceleration damping offer system stability without loss of velocity constant. High acceleration from stall insures rapid response to minimum error signals.



Damping is provided by the viscous friction induced by the magnetic coupling of a low inertia drag cup to a freely rotating magnet flywheel.

The rotor has an inertia of 0.34 gm.cm.^{2}. Combined with comparatively high stall torque of 0.33 oz. in. this produces acceleration at stall of 68,500 rad/sec^2. Upper corner frequencies approaching 41 cycles per second can be attained.

No-load speed is 6,000 rpm; flywheel inertia is 2 gm.cm.^{2}, and the flywheel damping factor is 52 dyne-cm-sec/rad. Power input is 3.3 watt per phase.

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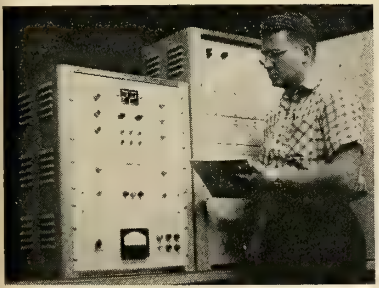

Designated ASCAT (Analog Self-Checking, Automatic Tester) the device is a compact unit combining high-speed, accurate and reliable performance with flexibility and simplicity of operation and maintenance.

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GUIDED MISSILES RANGE DIVISION
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space age

by Norman L. Baker

Lest we forget—It has been fourteen months since the Russians launched the world's first satellite, signalling the start of the space age. *Sputnik* I weighed 184 pounds—the weight of the final stage rocket that gave it its final boost is not known. The United States, during the same period, has successfully orbited a maximum satellite weight of 48.5 pounds (200-year *Vanguard* plus final stage). In May of this year the Soviets launched *Sputnik* III—payload weight: 2900 pounds; estimated weight of empty final stage rocket: 7000 pounds; total satellite weight: close to five tons.

Air Force satellites significant stride—Meanwhile, the Air Force is preparing to launch the largest U.S. satellites to date, the Discoverer series with satellite weights of 1300 pounds. NASA has plans for utilizing our largest rocket the *Atlas* for orbiting satellites up to 10,000 pounds, but availability of the vehicle is nearly a year away. Of course, within that same period of time the United States could have available enough rocket power, in the form of the 1.3 mega-pound-thrust *Jupiter* cluster, to overshadow the Russian satellite achievements to a place of insignificance.

Soviet manned satellite predicted—Top experts, such as former Lt. General James Gavin, do not expect the Russians to wait out future U.S. developments before they go on to greater achievements. For instance, Gavin thinks the Soviets will next attempt a manned satellite launching—having proved the feasibility of the program with *Sputnik* III and the animal-carrying high altitude rocket flights. Our manned satellite flights are at least a year away.

ICBMs—United States on par with Russia?—Most of the nation's press recently proclaimed the full-range *Atlas* flight as confirmation that we were now on a par with the Soviet Union in the ICBM missile race. Shortly before *Sputnik* I began orbiting the earth, Russia announced the successful flight of an operational ICBM. That was in August 1957, fifteen months before the United States was in a position to claim a similar achievement. If the Russian announcement is accepted as factual, that country has now had 15 months to carry out operational testing, production, launch site construction, and stockpile buildup, a program we are only now entering.

Water content of Mars—An electronic multiplier phototube, which converts light into an electrical signal, was installed on the instrumentated balloon capsule that was scheduled to be sent aloft last month to study the planet Mars. The tube, developed by IT&T, would have amplified the sunlight reflected from the surface of the planet and filtered by the Martian atmosphere. Through study of this infra-red absorption spectrum, scientists hope to learn whether the amount of water on the planet will sustain life. The flight of the balloon, carrying two men in addition to the instruments and scheduled for November 15, was postponed due to balloon failure.

Radiation protection by extract injection—Scientists of Atomic Energy of Canada, Ltd., report that a parathyroid extract can increase survival following irradiation by more than 50%. Experiments, using rats, are still being conducted to learn if the extract's ability to increase serum calcium is responsible for the protective powers, or if some other factor is at work.

REPORT
On Ground FM/FM Equipment

New standards of performance are being set by Data-Control Systems telemetry ground stations now in use in missile and space research programs. These stations are meeting the needs of all three services — Army, Navy and Air Force.

The stations incorporate the most recent advances in telemetry science and are characteristic of DCS leadership in the development of new techniques and products. All units have been custom designed with the exclusive DCS Data Modules

New Data-Modules

The DCS subcarrier discriminator is of the pulse-averaging type and incorporates the latest circuit techniques and components. Its performance is the best in its field. Among the features are an automatic input limiter, reduced sensitivity to changes in supply voltage and drift, chopper-stabilized output filters, and integral, completely automatic tape speed compensation circuits.

Switchable Tuning Unit

For use with the discriminator is the DCS switchable tuning unit containing modular switchable tuning units of 8, 16 and 24 channels The unit gives maximum flexibility and compactness.

Ground Voltage Controlled Oscillator Assembly is Modular

This DCS unit and its associated modules includes frequency modulated oscillators, summing amplifier, reference oscillator, frequency-determining plug-ins and a common power supply which together form a complete FM tape recording system with maximum flexibility. Modules are available for all IRIG data.

Write for full details to Data-Control Systems, Inc., 39 Rose St., Danbury Conn.

Typical ground station delivered to missile facility recently by Data-Control Systems, Inc

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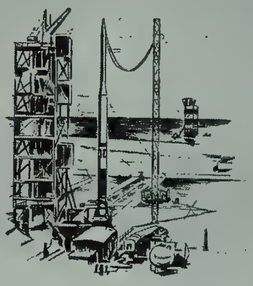
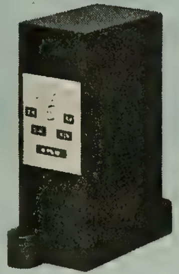




Model AOV-2S, G

VOLTAGE-CONTROLLED OSCILLATORS

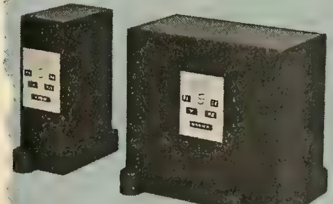
The AOV-2S offers a single power source 20 ma at 18 vdc ±20% B supply variation of 10% produces less than 1% of bandwidth frequency shift. Temp. stability better than ±1%, 20°C-100°C. Long-term operable to 125°C. Distortion less than 0.6%. Shock 100 g, vibration 20 g to 2000 cps specified, tested to 55 g. Linearity ±0.5%, input impedance 500K. Drives most transmitters without a mixer amplifier. AOV-2G offers a lower price, comparable performance, reduced temperature range

The AOV-3S offers miniature size (approx. 4 cu. in.), single 18 vdc supply. B supply variation of 10% produces less than 2% of bandwidth frequency shift. Temp. stability better than ±3%, 20°C-100°C Long-term operable to 125°C. Distortion less than 1%. Shock 100 g, vibration 20 g to 2000 cps specified, tested to 55 g. Linearity ±0.25%. Input impedance 100K. AOV-3G is same size at a lower price, comparable performance, reduced temp range

Model AOV-3S, G

ELECTRONIC COMMUTATORS

The APC-1 and power supply is all solid state, 75-900 samples/sec standard; other rates available. Commutator approx. 24 cu. in., 1½ lbs.; power supply 8 cu in.; 20 g at 2000 cps, 100 g shock. Noise less than 0.1%; random scatter between contacts 15 mv peak-to-peak; overall accuracy better than 1% Temp. stability 0.25% 20°C-100°C. Input impedance ½ megohm plus parallel load.



Model APC-1

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keeping track

by Peer Fossen

The full-range ***Atlas*** **flight** was accomplished at the sacrifice of telemetry gear. According to Patrick spokesmen, the *Atlas* vehicles successfully tested over limited range earlier this year could have gone the full distance had they not been weighted down by heavy instrumentation loads. Except for the telemetry gear, the short and long range vehicles were practically identical, with same fuel loads and burning time.

No additional tracking gear was employed for the 6,000 miles plus flight, the Patrick source said. The vehicle is tracked only up to time of burn-out which occurs approximately 4 to 5 minutes after launch. From there it is a straight ballistic trajectory, and if the impact prediction system at time of burn-out indicates that the vehicle is going to be on target, "then they don't care." Provided it does not break up in the meantime, it is a mathematical certainty where the missile will land, and no special tracking facilities are set up at the other end.

The telescope currently being built by the Russians at Leningrad Sovnarkhoz will be one of the largest in the world when finished. Mirror diameter is 102.5 in. The unit will have the height of a 20-story skyscraper. Once aimed at a star, the scope will "lock on" and follow the star continuously. Circular motion of the scope tube will be regulated by a complex automatic control system. Completion date is unknown.

Our various space travel programs are going ahead full steam, and it is interesting to notice that communications are one of the most highly developed aspects of space technology. This because better understanding of several phenomena is emerging from the data obtained from the U.S. and Soviet satellites. These vehicles have proved that current techniques are sound by successfully telemetering scientific data information from space to stations on earth.

Existing equipment limits operation to vehicles in near space. New and more sophisticated equipment will be needed for communication with space-craft bound for distant interplanetary places such as Mars and Venus. Techniques for development of such new equipment is, however, well understood, and the equipment could probably be engineered within a short period of time. According to leading scientists, no overwhelming problems are likely to prevent development of suitable equipment as rapidly as the vehicles that will require them.

One problem that remains to be solved, is transmission of intelligence beyond our solar system. Even if equipment existed, the round trip transmission time to our nearest star would be approximately nine years. As yet, there appears to be no way of circumventing the fundamental equivalence of space and time.

The U.S. Army's ***Juno*** **II** space rocket was given its final azimuth aim by a Perkin-Elmer Corp. precision theodolite. Since the rocket system was entirely free of external sources of guidance after launch, the azimuth command given to it was of utmost importance. Once in the air, the rocket's correctly aligned inertial guidance system produced signals necessary to counter any deviations in the azimuth heading.

The theodolite, so sensitive that it can detect deviations within the angle subtended by a dime a mile away, is an electronic-optical system which peers at a mirror mounted high in a missile on the one hand and at a known reference mark on the other. It continuously monitors the azimuth heading—the angle formed by the mirror in the missile head, the theodolite and the reference mark—up to the moment of launch. When any deviations in this angle occur, the theodolite automatically sends electronic correction signals to the drive elements of the platform which stabilizes the inertial guidance package.

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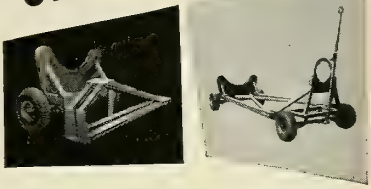

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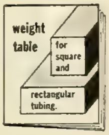

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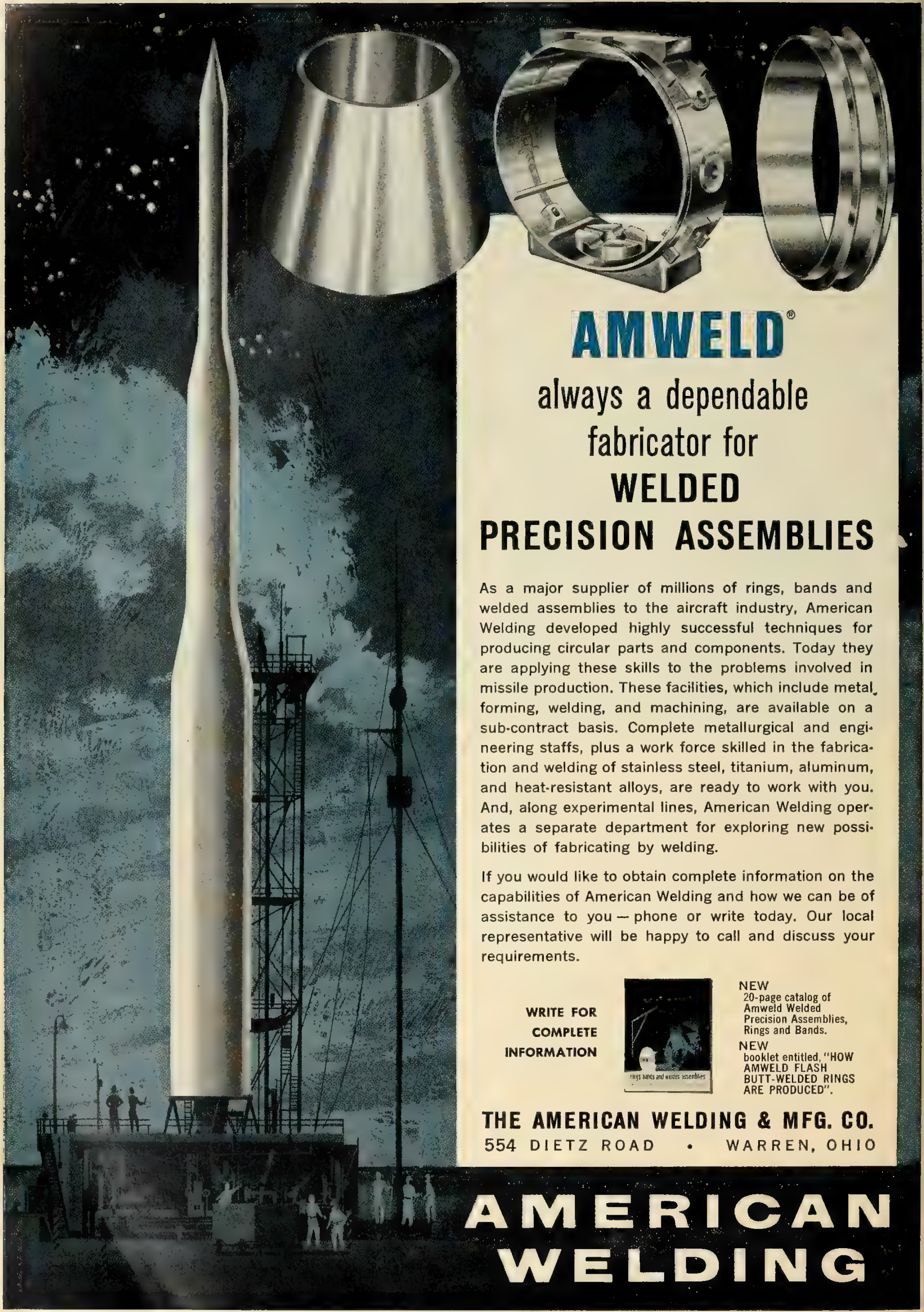
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ICBM Manpower Is Probed

by Erica Cromley

WASHINGTON—Congressional hearings on manpower utilization may boil over into an investigation of alleged waste in the Air Force ICBM program when Congress convenes next month. In the meantime, the Bureau of the Budget has been asked to tighten up on contracting authority.

The manpower subcommittee of the House Post Office and Civil Service Committee is seeking information on the Air Force's multi-million dollar cost-plus contract with the Thompson Ramo-Wooldridge Corp. which has technical direction and systems engineering.

Air Force officials were questioned closely about the 11.9% profit called for in the R-W contract. Salaries came under close scrutiny, and Air Force at the subcommittee's request is now determining how many scientists the service has lost to the company.

Overall profits actually earned by R-W on defense business fell below the figure cited by the subcommittee. The Renegotiation Board lists for the years 1955 and 1956—most recent figures available—profits of 8.1% and 9.7%, respectively. A report submitted by the Air Force to the General Accounting Office shows R-W total net profit of $5,099,000 after taxes from 1953 through 1957.

The company claims salaries are not excessive, and of 360 jobs offered in 1957, 160 were refused. Some 65% of refusals were because of low salaries. Only six corporate officials make over $30,000 a year, according to company records. Of 989 technical employees, 117 with an average of 17½ years experience earn between $15,200 and $25,000. Some 862 technicians and engineers, with an average of 10 years experience earn between $5,900 and $15,000. Only the top 10 of the technical staff—some of whom are also officials of the corporation—average $30,000 a year, according to R-W.

Subcommittee chairman James C. Davis (D-Ga.) said that while the ICBM program was a top-priority subject, the subcommittee wanted to know whether money was being wasted. A committee staff member added: "We're not saying they haven't done a good job, but we are interested in what it costs the taxpayers. We will look into this thing again next year to see if the situation has improved. We maintain these profits are excessive when there is no risk of loss." Davis told Elmer Staatz, assistant director of the Budget Bureau, that the bureau should clamp down on loose contractual practices by government agencies.

NASA Testing Space Capsule Off Wallops

LANGLEY AFB, VA.—A full-scale mock-up of the probable configuration of NASA's first manned space capsule is being air dropped from a C-130 in tests off Wallops Island.

Two drops, both under 10,000 feet, have been made to determine roll, pitch, tension, shock load and water impact characteristics. The configuration for which proposals were to have been received from industry on December 11, utilizes two parachutes. The first opens at 30,000 feet.

After being dropped, the capsule sheds its lid which releases the parachutes, and a dish-like beryllium heat shield.

Total weight of the test capsule is 1,700 pounds with about 500 pounds in the shield.

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The *E*-315 capacitor offers proven stability of operation over the temperature range of —55° to +315° Centigrade* with no voltage derating and low capacitance variation. Of rugged hermetically sealed construction and nonstrategic materials, this capacitor is built for high altitude and severe environmental operation.

This nonpolarized capacitor is available in a variety of sizes in a capacity range of from 0.05 to 4.0 microfarads at 600 VDC. It is also available in higher voltage ratings. Performance data and operating characteristics are given in Technical Bulletin SL-61 which is supplied upon request.

*Confirmed by qualification test of 1000 hours at 100% rated voltage over ambient temperature range of —55° to +315° C.

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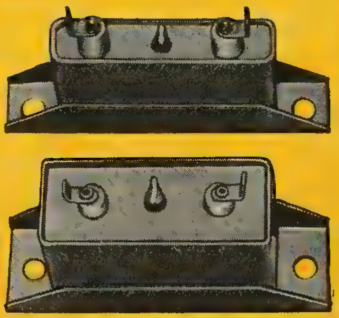

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DATA PROCESSING SYSTEM SPECIALISTS

the techniques of high speed data processing offers a big future for you

A missile comes "of age"—reaches operational status—as a result of many influences. Vital among these influences is the rapid incorporation in the test vehicle of modifications required by evaluation of flight performances. The faster these modifications are made, tested, and become incorporated in the design the faster the vehicle is declared operational.

The completion of this cycle is dependent too upon the speed with which vast amounts of test data can be reduced, analyzed, evaluated, and reported to the military and to the cognizant weapon systems contractors.

So, with the advent of missiles has come a revolution in data processing techniques—a revolution in which the Engineering Services of Telecomputing Corporation has been highly successful in greatly reducing the elapsed time for complete processing of missile flight test data.

This is an invitation to join the data processing specialists who comprise the Engineering Services Staff—a Staff which establishes the state-of-the-art in data processing techniques and methods as we go about our job of computing the performance of missiles under test at the White Sands Missile Range.

Join us and work with high speed digital computers and other modern data processing equipment in reducing the test data from scientific data measuring systems such as, cinetheodolites, electronic measuring systems, precision optics, and telemetering systems.

Join us—and grow with us—as our advanced processing techniques are employed in this fascinating field of missile flight testing so important to our national defense effort.

Make your home in New Mexico's land of enchantment—mountain skiing and resorts just 30 minutes away—attractive salaries with area bonus — profit sharing — relocation pay—group insurance. Send your resume today to the Director of Technical Personnel.

engineering service division

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missile people

William M. Duke has been appointed director of the Systems Engineering Division of Space Technology Laboratories, Inc. Elected a vice president of the Laboratories in April, 1958, Dr. Duke has had 23 years experience in helicopter aerodynamics, structural experiment, analysis and design, powerplant analysis and installation, materials research, aircraft preliminary design, applied mechanics research, and missile systems and component research.

He is the recipient of a Bureau of Aeronautics' Commendation Letter, a Naval Ordnance Development Award and the Centennial Citation from New York University. Prior to his election as a laboratories vice president, he served as director of the ICBM *Titan* Weapon System.

Appointment of **Brig. Gen. H. F. Gregory,** (ret.) as vice president and assistant to president **G. R. Morrow,** of Midwestern Instruments, Inc. has been announced. He recently retired as Commander of Air Force Office of Scientific Research, Air Research and Development Command, USAF. He had been in command of the headquarters office there since 1956 and had been air attache at the American embassy in Paris, France during the four previous years.

Dr. Ernst Stuhlinger, director of the Research Projects Laboratory, of the Army Ordnance Missile Command was elected a Fellow Member by the American Rocket Society at the organization's annual meeting last month, "in recognition of his distinguished contributions in the field of astronautics."

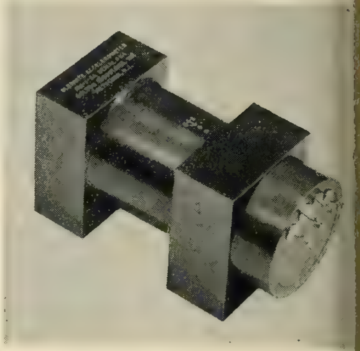
Dr. Malcolm R. Currie, co-head of the electron dynamics department of Hughes Aircraft Company, Culver City, Calif., was named the "outstanding young electrical engineer of 1958" by Eta Kappa Nu, national honor society.

W. R. Clay, formerly director of Engineering of the Research and Development Section of Rheem Manufacturing Co., has been appointed assistant to the vice president of Engineering of Radioplane, a division of Northrop Aircraft, Inc.

The following new appointments have been announced:

John G. Copelin, a vice president and comptroller of International Telephone and Telegraph Corp.; **Col. Henry H. Wishart,** Chief of the Industrial Division of the Army Rocket and Guided Missile Agency; **Harold T. Morris,** Air Force Plant Representative to Northrop Aircraft, Inc.

Magnetic damping in minimum volume



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west coast industry

by Fred S. Hunter

In its third quarter financial report, the Douglas Aircraft Co. noted that missile sales accounted for about half the company's military backlog at the end of the period. This is significant in view of the fact that the ratio of missile sales to total military output in 1957 was 27%. In 1956 it was 16%.

There are other eye-openers in the Douglas figures. The total backlog, military and commercial, as of February 28 was $1.638 billion. As of May 31, it was $1.583 billion. As of August 31, it was $1.584 billion. There was little change in the six months between February 28 and August 31; practically none at all between May 31 and August 31.

What was Douglas selling to maintain so steady a backlog at the same time it was delivering an average of $300 million per quarter in finished products? Few DC-8s were sold in this period, and about the only real big contract Douglas has announced lately was the $75 million Navy order for A4D aircraft and this did not come until after August 31. The only conclusion to be drawn is that the stabilizing effect on the Douglas backlog is coming from missile business, notably the *Thor* IRBM, on which no dollar volumes have been announced.

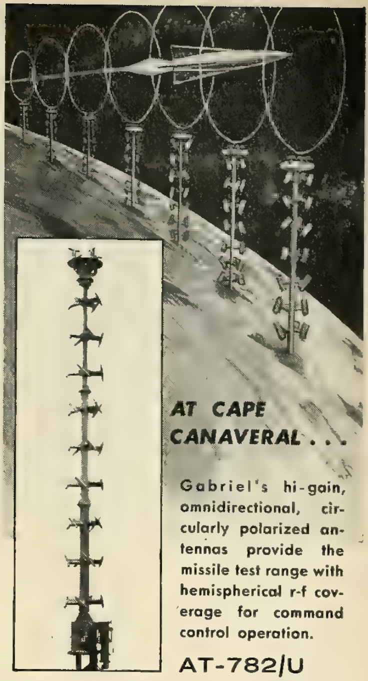
More light was thrown on the extent of the *Thor* program the other day in Long Beach when Col. Dean E. Hess, Chief of the Air Force Office of Information Services in Los Angeles, appeared on the scene to answer to noise complaints from residents and reported on the flow of material in a big C-124 airlift from the Long Beach Municipal Airport to *Thor* bases in Britain.

Explaining the 15-hour turnarounds which resulted in the heavily loaded C-124 takeoffs from Long Beach at all hours, Col. Hess told the Long Beach people he saw little possibility in the troubled world situation to eliminate the airlift of missiles and missile-support equipment to the NATO defense bases in Britain. Moreover, the 30 to 40 C-124 flights a month is being increased to 70 this month.

It is no secret that Douglas has been in production on the *Thor* for more than a year now. Back in July, the Douglas Company forecast that employment at its Santa Monica Division would decline from a high of 27,000 to 20,000 by November 30, because of the phase-out of DC-6/7 aircraft production. Actually, the decline stopped at around 22,500. The aircraft production workers are gone, but increases are taking place in other areas.

One of these areas is service, growing rapidly in the missile field. Training is another. When it was training Royal Air Force crews in the *Thor* program at Tucson, Douglas was hard put for people to teach the NATO missile airmen. This problem promises to become even more complicated at the new Vandenberg Air Force Base ballistic missile training facility, particularly if *Thors* are the IRBMs selected for other NATO countries, such as France, Germany, Italy and Turkey.

Marquardt Aircraft, which now has to ship its *Bomarc* ramjet engines from its manufacturing plant in Ogden to California for testing, will start putting people on the payroll shortly after the first of the year for its new test facility in Utah and should have it in operation about the middle of the year.



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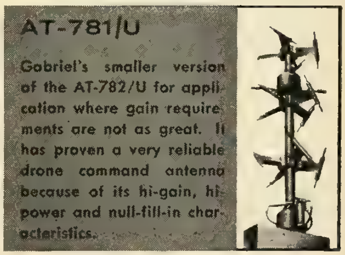

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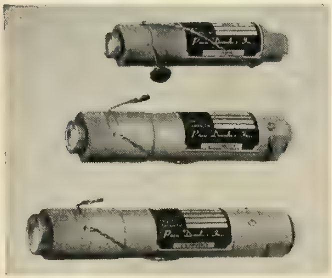

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world astronautics

by Frederick C. Durant III

The British Interplanetary Society recently sponsored a highly successful space medical symposium. In addition to the usual survey and "state of the art" types of space medical papers, several human engineering treatises were presented. In "The Physiological Effects of Transient Mechanical Forces: A Review of Their Relevance to Astronautics," Flight Lieut. J. C. Guignard of RAF Institute of Aviation Medicine reviewed possible mechanical stresses which will affect man during ascent, re-entry and certain presumed operations in space. In addition to plus, minus and zero g-loadings, a wide variety of potential combinations of vibration frequencies are possible as well as tumbling or spinning around various axes. J. Billingham in "Heat Exchange Between Man and His Environment on The Surface of The Moon" analyzed the heat exchange between men and a lunar space suit, and the suit and surroundings at different times and places on the moon.

These and other significant papers point clearly to the fact that competent scientists and engineers in any country can contribute to the many, in fact the vast majority, of current problems which face man in contemplating space flight. It has been said (and will probably have to be reiterated many times) that a country which has developed large rocket launching vehicles does not in the course of such experience become magically endowed with superior intellect for the solution of the multifarious problems attendant to space exploration. The reason for the existence of large rocket vehicles is a combination of geopolitical factors based upon national wealth and defense requirements, not a unique national "corner on the brains market." This point becomes obvious when one considers, in addition to the names of Tsiolkowski and Goddard, such names as Oberth, Esnault-Pelterie, Congreve, Siemienowicz, Von Pirquet, Crocco and many others.

Did you recognize the name Siemienowicz above? Almost unknown, Polish Kasimierz Siemienowicz was apparently the first to suggest the step-rocket, clustered rockets and delta-winged rockets in the Seventeenth Century. His monograph on the art of artillery was published in Holland in 1650 and subsequently translated into German, French, Dutch and English. Drawings published in this work show clearly his technical appreciation of all of these concepts. More information on this interesting bit of rocket history is being sought.

The Svensk Interplanetarisk Salskap offers one service to its members not known to be matched by other societies: an abstracting service of astronautics articles appearing in periodicals. Several times a year members receive a stack of mimeographed sheets on significant news items from national trade magazines and publications of other spaceflight societies. In addition, numbered library cards in classical form, printed in Swedish, of technical papers provide each member with his own astronautical library catalog.

Four "student groups" have been organized by the German Deutschen Gesellschaft fur Raketentechnik und Raumfahrt e. V. at the Technischen Hochscule at Karlsruhe and Stuttgart and the Universitat at Tubingen and Marburg/Lahn. Four sections of the DGRR, known as Landesgruppen, are active in addition to the headquarters at Stuttgart: They are located at Baden-Wurttenburg, Hamburg/Schleswig-Holstein, Nordbayern and Rheinland-Pfalz.

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book reviews

APPLICATION OF ATOMIC ENGINES IN AVIATION, Military Press of the Ministry of Defense of the USSR, 180 pp., $3.00, Foreign Technical Information Center, Office of Technical Services, Department of Commerce.

Written by Soviet nuclear and rocket experts in 1957, this book is a good guide to Russian thinking on the subject of nuclear powerplants for aircraft, missiles and spacecraft.

It is concerned with the feasibility and potentialities of nuclear engines and was published "to systematize the scattered data in the literature on the utilization of atomic powerplants in aviation and rocket engines."

General design, specifications, and types of airborne nuclear reactors are also examined. Possible diagrams of atomic powerplants are illustrated and discussed. These include such combinations as ramjet-atomic, turbojet-atomic, turboprop-atomic, and atomic rocket. Radiation shielding and special features of design are covered as well as inflight operation and ground servicing.

A full chapter is devoted to the use of atomic engines for interplanetary flight. Advantages of nuclear fuels for space flight, projected atomic space rockets, and a proposed program for attaining cosmic speeds is discussed.

RUSSIAN-ENGLISH GLOSSARY OF GUIDED MISSILE, ROCKET, AND SATELLITE TERMS, compiled by Alexander Rosenberg, 352 pp., $2.50, Card Division, Library of Congress, 1958, Washington, D. C.

This work should prove extremely valuable to anyone attempting to use Russian sources in the missile, rocket and satellite field. Containing over 4000 entries, the glossary has been compiled from official Soviet sources published in the period 1955-1958.

It has heretofore been necessary to consult a number of sources for accurate translation of astronautical terms, and extremely few Russian-English dictionaries cover this field.

This volume is printed in large, clear type and gives both abbreviated and full forms of many terms. Listing is made in each of the several ways a term may be encountered. For example, "Newtonian particle reflection" is also found under "particle reflection, Newtonian."

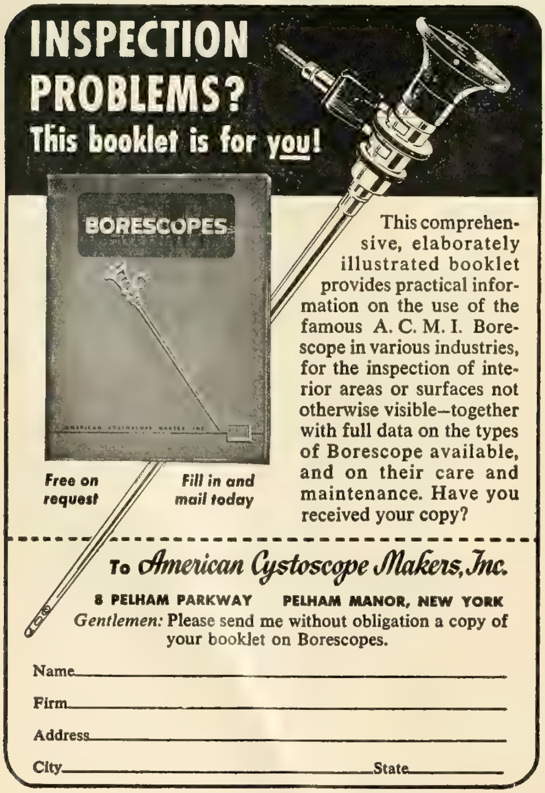
The glossary is highly recommended for those engaged in translating, abstracting or research.

GUIDED MISSILE ENGINEERING: Edited by Allen E. Puckett and Simon Ramo; 512 pages, 213 illustrations, $10; McGraw-Hill, New York.

Two well-known names to misslemen, Allen Puckett, associate director of Hughes Aircraft Co.'s systems development laboratories; and Simon Ramo, president of Space Technology Laboratories, collaborate in an introduction to guided missile engineering.

Seventeen other eminent specialists, each representing a particular field, cover electronics, guidance theory, aerodynamics, airframe performance and other subjects underlying various phases of guided missile engineering.

A combination of theoretical and practical material, the book emphasizes systems engineering aspects of the subject. Topics covered include: missile system and its components; aerodynamics; stability and control; the rocket motor; information theory and missile guidance; principles of missile navigation; random phenomena; gyrocopy; radio propogation; microwaves; radar; analog and digital computers; integration of design.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DECEMBER

Fourth Convertible Aircraft Congress, The Franklin Institute, Philadelphia, Pa., Dec. 16.

American Astronautical Society, Fifth Annual Meeting, Hotel Statler, Washington, D.C. Meeting will be held in conjunction with the 125th Annual Meeting of the American Association for the Advancement of Science, Dec. 27-30.

JANUARY

Reliability and Quality Control in Electronics, Fifth National Symposium, Bellevue-Stratford Hotel, Philadelphia, Pa., Jan. 12-14.

Society of Automotive Engineers, Annual Meeting and Engineering Display, The Sheraton-Cadillac and Hotel Statler, Detroit, Jan. 12-16.

Southwest Electronic Exhibit, Arizona State Fairgrounds, Phoenix, Ariz., Jan. 21-23.

Fifth Annual Radar Symposium (classified), Rockham Bldg., University of Michigan, Ann Arbor, Mich., Jan. 27-29.

Society of Plastics Engineers, 15th Annual Technical Conference, Hotel Commodore, New York, N.Y., Jan. 27-30.

Armour Research Foundation, Fifth Annual Midwest Welding Conference, Illinois Institute of Technology, Chicago, Ill., Jan. 28-29.

Nuclear Fuel Elements, First International Symposium jointly sponsored by Columbia University and Sylvania-Corning Nuclear Corp., Columbia University, New York City, Jan. 28-29.

FEBRUARY

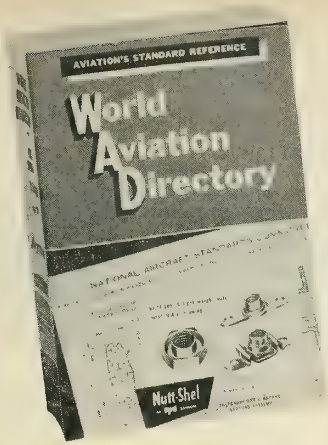
14th Annual Technical and Management Conference, Reinforced Plastics Div., Society of the Plastics Industry, Inc., Edgewater Beach Hotel, Chicago, Ill., Feb. 3-5.

IRE, AIEE 1959 Solid State Circuits Conference, University of Pennsylvania, Philadelphia, Pa., Feb. 12-13.

MARCH

IRE, AIEE and Association for Computing Machinery, 1959 Western Joint Computer Conference, Fairmont Hotel, San Francisco, Calif., March 3-5.

Gas Turbine Division of the American Society of Mechanical Engineers, turbine in action, Cincinnati, Ohio, March 8-11.



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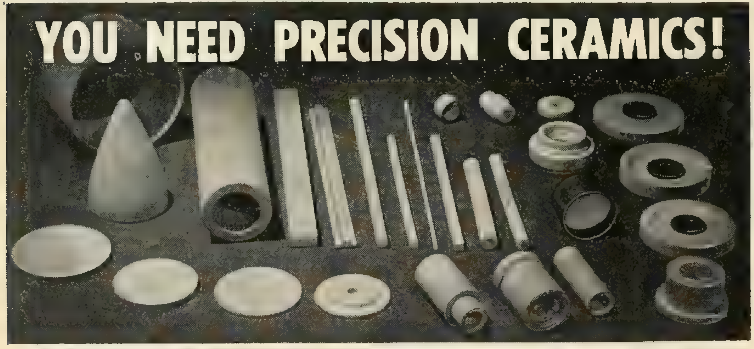

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Give Us A Goal For The Space Race

As of this writing the United States has placed two small satellites in orbit, has failed on several other similar attempts, has attempted four times to place a payload in the vicinity of the moon, has shot several space rockets from a balloon for some reason or other and has half a dozen-odd other projects in view.

We also have three government agencies, three military services and a fair segment of the national industry involved in the almost frantic effort to do something in one way or another regarding our solar system.

In all of this—if there is a planned program as to what we are trying to do on what schedule and for what purpose, that fact is not apparent.

This magazine would like to suggest a few procedures. If they have been considered by those whose job it should have been, the suggestions won't do any harm. Otherwise, they might help. To begin, let us:

Define the national goals in the space race.

Establish a program to achieve those goals.

Develop the organization to carry out the program.

As a beginning and under the impression that no one in the government has realistically done so, m/r would like to define our goal in one simple tough sentence.

The goal:

Until the world is guaranteed that space occupation of our solar system is for peaceful purposes, the United States can take no chance on its being dominated by someone else.

This is based on the premise that he who controls space around it can control the earth. Until we find out differently this is an assumption we must make. Our continued existence depends on it. Achievement of the goal includes, naturally, the exhaustive exploration of space necessary to achieve a preemptive veto power over any other control.

• Establish a program to achieve those goals. There is no doubt that even with the present shotgun approach to the problem we have accomplished some success. There is no doubt also that we are wasting money and what may be very precious time for the lack of reasoned and defined intentions. With a goal established, what are the steps we need to achieve it? They could be these, or some variation thereof:

1) Orbit the moon. 2) Orbit Venus and Mars. 3) Establish a reconnaissance satellite. 4) Man in space. 5) Soft landing on the Moon, Mars and Venus. 6) Establish a space platform. 7) Hard landing on the Moon. 8) Planetary and lunar bases.

There may be other steps and those above probably would not be taken in exactly that order. We'll accept a better plan. In fact, we'll accept almost any coherent plan in lieu of none.

• Develop the organization to carry out the program. At the moment we don't have one organization carrying out our space program, but we do have three government agencies, three services and a lot of industry trying. There is the National Space Council, the National Aeronautics and Space Administration, the Advanced Research Projects Agency, the Army, Navy and Air Force, plus a couple of hundred prime contractors.

The National Space Council, headed by the President and advised by Dr. James R. Killian, has to decide which space projects shall be attempted, and in what priority.

NASA, under Dr. T. Keith Glennan, has the responsibility for non-military space projects. It is destined to get more money and become more powerful, as it must. At the moment, however, NASA has been blocked by the President from getting the scientists it desperately needs from the Army and hasn't even the urgent authority it needs to cut Civil Service red tape to get minor officials.

ARPA, headed by able Roy Johnson who reports directly to Defense Secretary Neil H. McElroy, allocates military space projects among the services. ARPA fears military space projects will be neglected under NASA's growing authority and there is a less than cordial exchange of information between the agencies.

The services, distrusting the practical hardheadness of scientists, reach under the counter for money to finance developments which are kept secret even from ARPA until they are virtually accomplished facts.

U.S. industry is the power and glory behind America's space program. It is the main reason the space program will succeed. For every scientist in the services and civilian agencies, industry has ten. The U.S. will spend $8 billion tax money next year on missile and space projects and, while earning legitimate projects, will pour millions of its own dollars back into research for the future. Industry's peculiar problem is frustrating official indecision and even occasionally mismanagement and favoritism.

With all of these involved in the space race, there is in this country no one agency, department or office through which all space projects clear. There is no one man, group or organization which establishes the goal or lays out the program for the country to follow. We have a team but it is charging off in all directions at once.

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missiles and rockets

For additional information about any product or service advertised or mentioned in the editorial pages of this issue of Missiles and Rockets:

Use the attached prepaid reply cards. Circle numbers shown on he reply card that correspond with numbers appearing beneath items lescribed. If no circle number accompanies the article or advertisement, give page number (and advertiser's name) on line provided at oottom of the card.

Your requests for information will be forwarded promptly to the companies concerned.

NEW PRODUCT BRIEFS

LAY LINES. Digitronics Corp. announces several additions to its standard its of model IR continuously variable ay lines. Each of the lines are comtely hermetically sealed and feature inite resolution. The new delay ranges ilable are from 0.18usec to 0.22usec, 3usec to 0.27usec, 0.28usec to 0.32c, 0.33usec to 0.37usec, 0.48usec to 2usec and 0.58usec to 0.62usec. Chareristic impedance is 250 ohms, with her impedances are readily availe. Other characteristics are a rise e of 0.06usec and a maximum atuation of 1.0 db according to the nufacturer.
le No. 275 on Subscriber Service Card.

PACITOR TESTER. Systems Engineer-, Division of Paul Hardeman, Inc. retly placed on the market a precision acitance and temperance coefficient er for checking the reliability factor capacitors over a given temperature ge. The tester is a self contained designed to measure capacitance temperature coefficient of capacis over a range of –65° to +175°C.
le No. 276 on Subscriber Service Card.

ANSISTOR TRANSFORMERS. A new of fully mu-metal shielded miniature nsformers explicitly designed for tranor application is available from Amier Corp. of America. This series of gedized transformers are epoxy imgnated for optimum freedom of isture penetration and are housed in wn, annealed after stamping, mutal shields. Hermetically sealed units structed in accordance with MIL-T-\ specifications are also available. units use the best type of nickely core material and are wound up either bakelite molded coil forms or on bobbins. Bifilar windings and ace gapless core construction are ized in some units. All transformers color coded in accordance with TMA standards. Thirteen basic types input, driver, output and interstage nsformers are available for use in 90 erent impedance matching circuits.
le No. 277 on Subscriber Service Card.

GH TEMPERATURE WIRE. Readyuse, flexible, ceramic-type insulated e rated for continuous operation at 0°F is described in this technical letin. Applications and handling chareristics are covered, and the bulletin contains graphs, charts other deptive data. Hitemp Wires, Inc.
le No. 278 on Subscriber Service Card.

GEAR HEADS. Fae Instrument Corp.'s size 11 precision gear heads are designed for use in conjunction with standard BuOrd Mk Mod. 2 (size 11) servo motors and through use of available adapters to other than size 11 motors and systems. All are built for high and low temperature applications and environmental tests covered by MIL-E-5272A.
Circle No. 279 on Subscriber Service Card.

SMALL ROCKET MOTOR. Armstrong Siddeley Motors, British manufacturers of liquid propellant rocket engines, have announced development of a small rocket motor for auxiliary use in missiles. The Armstrong Siddeley PR.23, according to the manufacturer, can be used for trimming the attitude and velocity of long-range ballistic missiles. The unit, weighing 3032 lb., is entirely self-contained and gives a thrust of about 500 lb. with a high specific impulse. Smooth control of thrust can be obtained down to at least one-third full power, with only slight reduction in S.I.
Circle No. 280 on Subscriber Service Card.

OPTICAL INSTRUMENT. The "Omniscope," a new optical instrument with a 180° hemispheric field of view, is announced by the Lerma Engineering Corp. Built as a periscope or borescope, it transmits this extremely wide angle field of view from inaccessible, hazardous, or remote regions. The Omniscope can be furnished in lengths up to 40 feet, with offsets and angles to suit the configuration of the installation. Other features, such as underwater design, sectional construction, non-browning optics, shielding, special illumination and photographic attachments available.
Circle No. 281 on Subscriber Service Card.

LINEAR INDUCTION POTENTIOMETERS. Kearfott Co., Inc.'s new series of linear synchro transmitters has been added to standard group of synchros. Dimensionally identical to Kearfott's R900 Series synchros, these components are highly linear induction potentiometers providing accurate linear indication of shaft rotation about a reference position in the form of a polarized voltage whose magnitude is proportional to angular displacement. Phase relationships indicate direction of shaft rotation. Being of the induction type, the potentiometers need no sliders to make electrical contacts. The units are furnished with either terminals or leads, and with special shaft configurations.
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126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150
151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175

• • Missile Literature

200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224

• • New Missile Products

225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249
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MISSILE LITERATURE

PRESSURE TRANSDUCER. Four-page bulletin on model S-30 unit, a dual-coil, variable reluctance diaphragm type pressure transducer designed for voltage output, bridge type circuits, carrier systems, telemetering systems and servo control applications. Ultradyne, Inc.

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VOLTAGE REFERENCE SOURCES. Brochure describes "ultra-precision" voltage references sources, and covers three models, the VR-607 portable decade unit, the VR-608 rack mounting decade unit and the VR-607B portable binary model. Epsco Instrument and Equipment Division.

Circle No. 200 on Subscriber Service Card.

CRYOGENIC PUMPS. Four pumps for use with liquified atmosphere gases are described in a four-page folder which includes detailed information on the performance and specifications for two turbine type and two immersed reciprocating pumps. Specially designed for service with liquid oxygen, nitrogen and argon. Linde Co., Division of Union Carbide Corp.

Circle No. 201 on Subscriber Service Card.

SURFACE COATINGS. Brochure, 12 pages, describes Eccocoat Surface Coatings intended for electrical and electronic applications for use in component protection, printed circuit boards, hermetic sealing, etc. Emerson & Cuming, Inc.

Circle No. 202 on Subscriber Service Card.

POWER FOR AUTOMATION. A revised, up-to-date version of the bulletin "A New Approach to Practical Control" is available. The 8-page bulletin, 765A, gives complete engineering data and describes typical applications of Regatron programmable power packs. New models and revised specifications are included. Electronic Measurements, Co. Inc.

Circle No. 203 on Subscriber Service Card.

OPTICAL EQUIPMENT. A 96-page catalogue containing data on essential equipment for visual inspection, comparison, checking or measurement. Hundreds of quality-control aids are listed, as well as more than 1000 optical items. Edmund Scientific Co.

Circle No. 204 on Subscriber Service Card.

ANTENNA SYSTEMS. Catalog covers antennas, systems, and transmission line products in 96 pages. Includes developments in 21-inch waveguide, high-power lines, ground-to-air and telemetry antennas, etc. Contains 16-page section of general antenna systems engineering information. Andrew Corp.

Circle No. 205 on Subscriber Service Card.

LOW-NOISE HF PREAMPLIFIERS. Four-page brochure illustrates and gives detailed electrical and mechanical data on line of low-noise, high frequency preamplifiers. Series "A" models are fixed-tuned preamplifiers available with flat bandwidths in the range 50 to 500 mc. Series "B" units are available for any center frequency in the range 100 to 250 mc., depending on frequency center. Special models are also describ
A. R. & T. Electronics, Inc.

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SERVOS & AMPLIFIERS. Illustrated b
letin covers synchro transmitters, tra
formers, receivers and differential tra
mitters with stainless steel housin
thru-bore construction, accuracies
±7' and torque gradients of 2400
MM/degree. Also includes size 8 se
motors offering high rate of stall tor
to power input (0.025 oz. in. for
watts input). Bulletin describes Size
transistorized amplifiers with a volu
of 0.8 cubic inches and capable of
livering 2 watts of continuous po
output at 100° without a heat s
Ketay Dept., Norden Division of Unit
Aircraft Corp.

Circle No. 207 on Subscriber Service C

ENGINEER'S HANDBOOK. A new s
plement to the handbook published
CBS-Hytron has been issued, offer
revised data for 14 types, as well as
pages of revised curve sheets. CBS-
tron.

Circle No. 208 on Subscriber Service C

SPECIAL CHARTS. A new bulle
#Y1906, describing charts for spec
requirements, including pre-printed ph
charts for oscillograph recording,
been released by the Bristol Compa

Circle No. 209 on Subscriber Service C

VERTICAL SCALE INDICATOR. A te
nical report on the ATC vertical sc
indicator used with Atcotran differ
tial transformers to display linear me
urements of such variables as moti
pressure, liquid level, thickness, e
has been published by Automatic T
ing and Controls, Inc.

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HYDRAULIC RESEARCH. Latest in
series of publications summing up
ports on hydraulic research in the p
year in the U.S. and Canada. Serves
a guide in the coordination and pla
ning of work in this field and is a co
tribution to the effort to elimina
duplication of work. Contains 168 pag
$1.25. U.S. Department of Commerce

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MERCURY SWITCH. Low-angle swit
described in one-page data sheet whi
gives photograph, dimensions, specific
tions, and electrical rating. Switch
smallest single-pole, double-throw me
cury switch available. Differential ang
is .15° maximum. MICRO SWITCH D
vision of Minneapolis-Honeywell Reg
lator Co.

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TEST EQUIPMENT. Bulletin 1374,
illustrated folder, covers products, ser
ices and facilities of Nankervis Co.

Circle No. 213 on Subscriber Service Ca

DIGITAL TEST EQUIPMENT. Data fold
provides specifications and prices
transistorized equipment, covering
standard building blocks produced
Digital Equipment Corp.

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126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150
151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175

• • Missile Literature

200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224

• • New Missile Products

225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249
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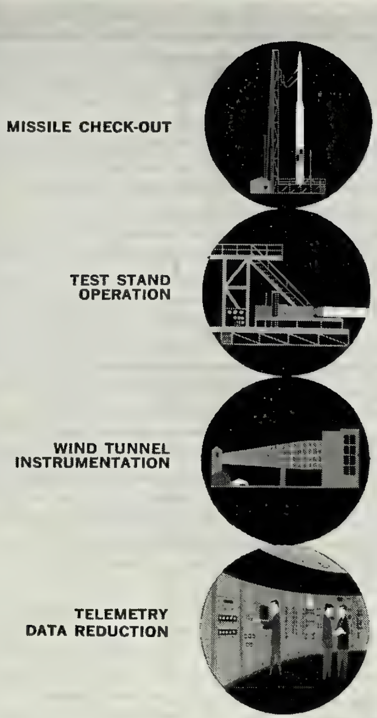
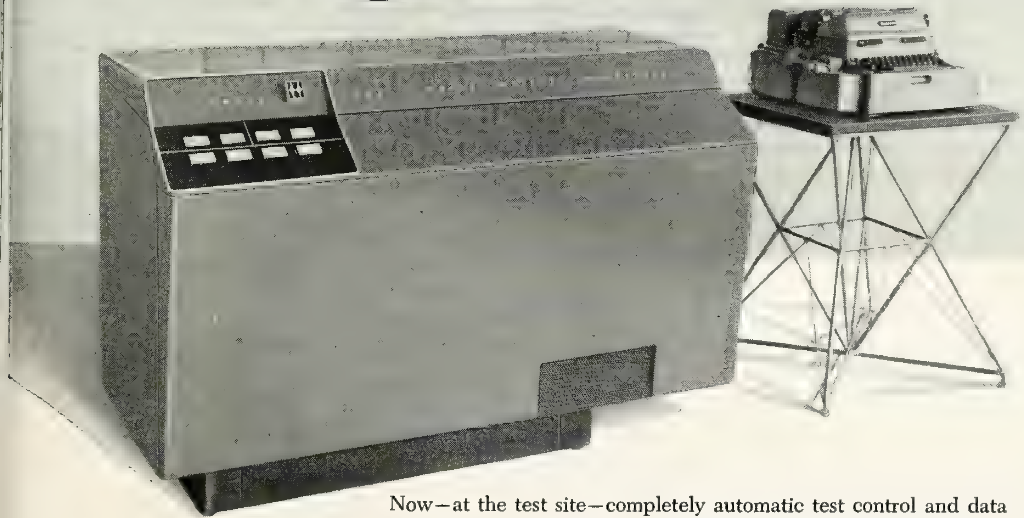
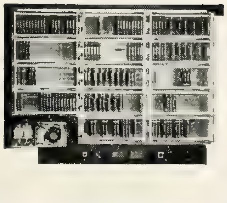


The RW-300 is the first digital computer for test control and data reduction



Now—at the test site—completely automatic test control and data reduction can be handled by a single system incorporating the Ramo-Wooldridge RW-300 Digital Control Computer. The new RW-300 can schedule and closely control test routines, and it can collect, analyze, and record test data.

The versatile RW-300 utilizes input data as feedback to modify control actions, thus substantially shortening many test routines. In addition, the RW-300 directly logs both instrument data and complex relationships among these data. Thus, test results are available immediately. The time-consuming task of processing raw data through a separate computer, often remote from the test facility, usually can be eliminated.



For technical information on automatic test control and data reduction with the RW-300 and with special digital systems which utilize solid-state components exclusively, write: Director of Marketing, The Thompson-Ramo-Wooldridge Products Company, P.O. Box 90067, Airport Station, Los Angeles 45, California, or call OSborne 5-4601.

THE THOMPSON-RAMO-WOOLDRIDGE PRODUCTS COMPANY

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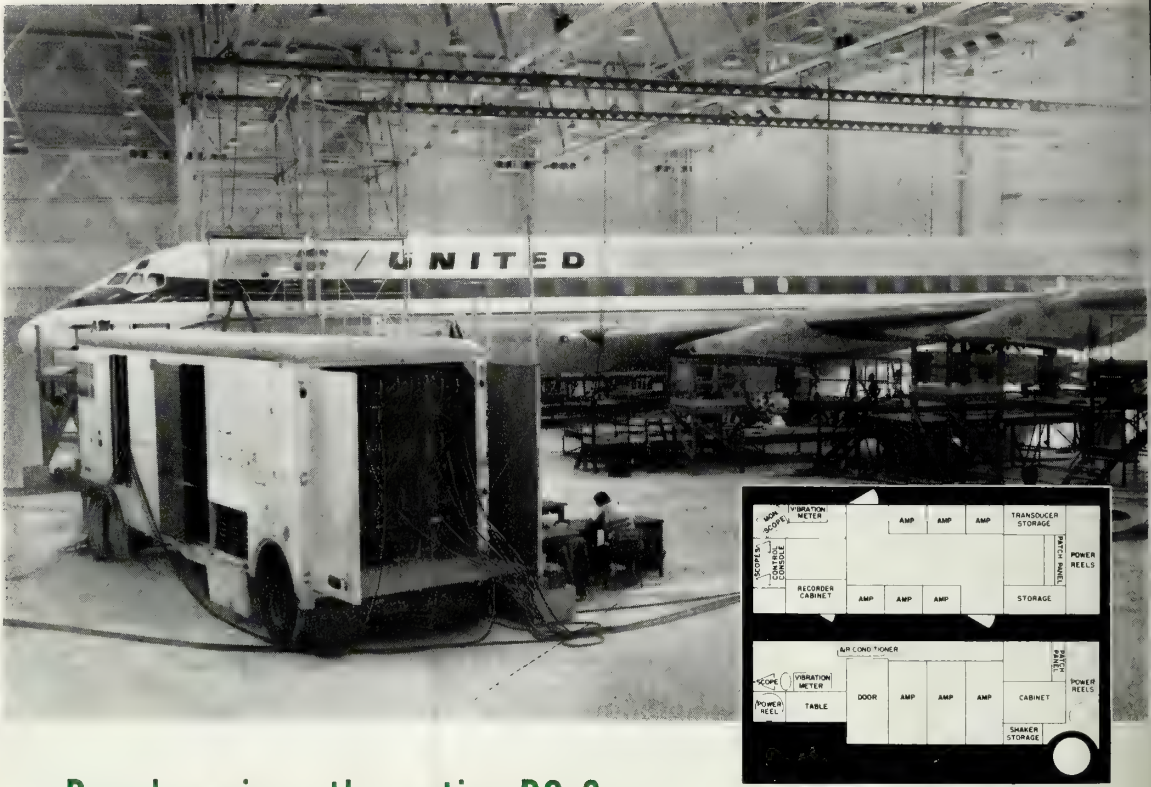


COMPLETE, COMPACT LAB—control center at forward end . . . six amplifers in the center and patching panels with power reels at the rear.

Douglas gives the entire DC-8 a vibration "shake-down" with this new mobile test laboratory

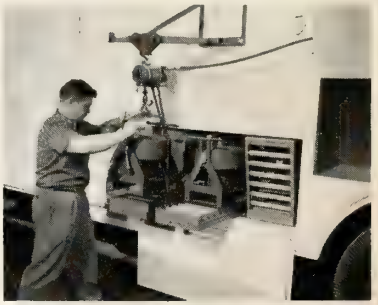
A complete Ling vibration testing laboratory on wheels allows Douglas Aircraft to simulate actual flight vibrations without ever leaving the ground!

This new Ling unit is a self-contained laboratory, with up to 12 shakers integrated into a single system.

For the first time it provides an efficient means of testing the entire aircraft, missile or other large component while fully assembled. Structural vibrational characteristics of the complete airframe can be determined under various dynamic loadings, and the chances of test inaccuracies through mismatched or temporary connections are reduced. Further, important time and money savings are realized with this on-the-job test lab.

A new bulletin giving full information and specification data on this new Ling mobile unit will soon be available. Write for your copy now!

MASTER CONTROL CONSOLE features front panel reading and easily accessible control of all basic system functions.



ACCESSIBILITY OF EQUIPMENT includes roll-out storage of 12 shakers, power reels and equipment check-out.

LING ELECTRONICS INC.

LING-CALIDYNE FACTORY SALES OFFICES

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Winchester, Massachusetts

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PLASMA ARC TORCH—
New Missile Production Tool

DECEMBER 22, 1958

missiles and rockets

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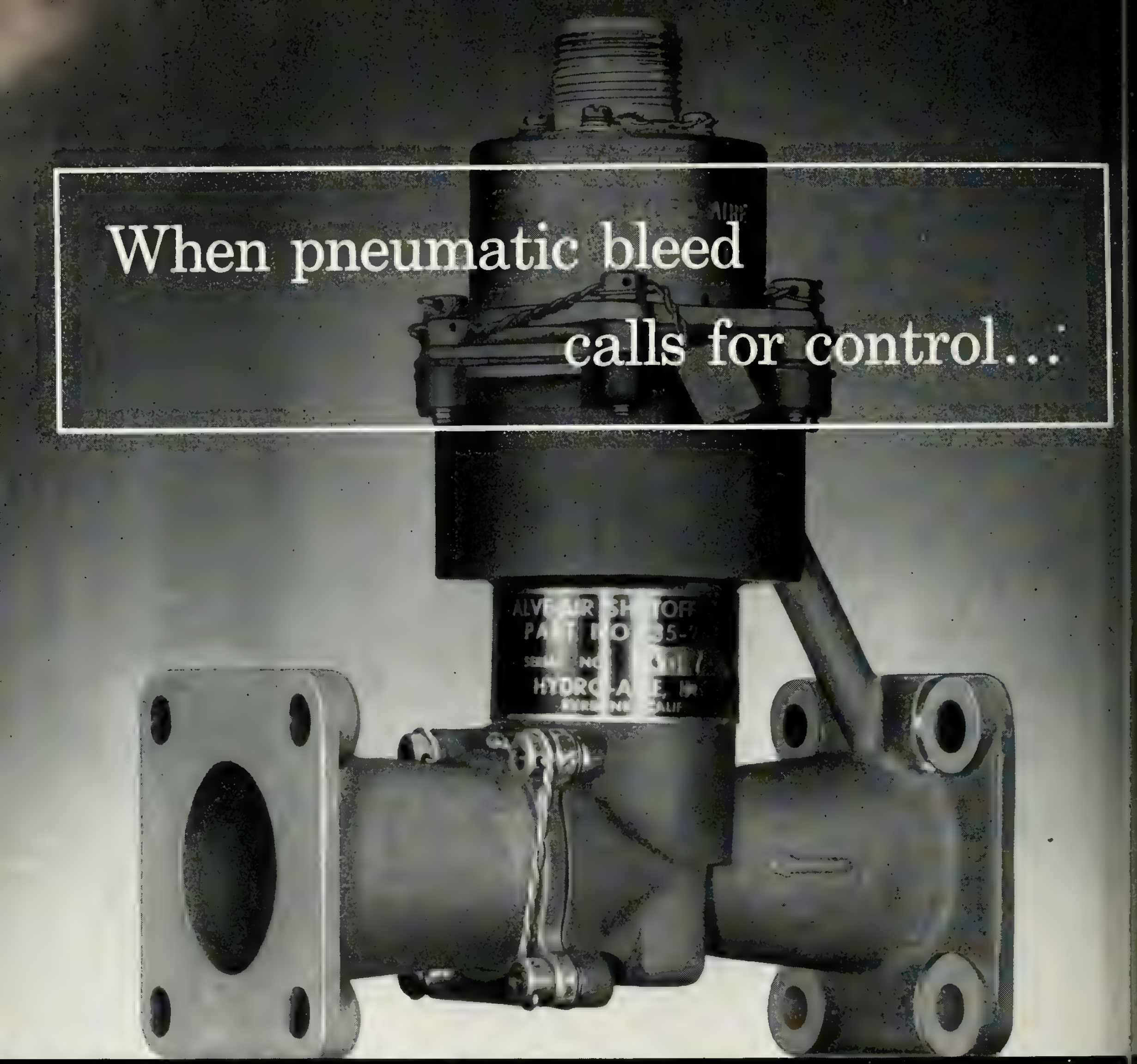
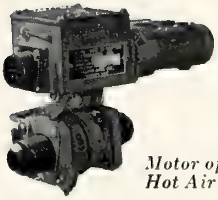
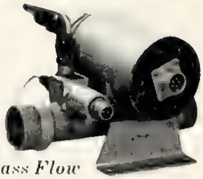
News and Business Edition

AN AMERICAN AVIATION PUBLICATION

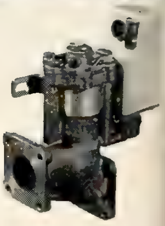




*Motor operated
Hot Air Butterfly Valves*


*Mass Flow
Control Valve*

*Pressure Regulator
& Anti-Icing Valve*



the answer is right in this family

The featured player on this page is one of the latest additions to Hydro-Aire's family of pneumatic controls: a fast acting (less than a second) D.C. solenoid operated hot air shutoff valve. All dressed up in a precision casting (for low weight), it is ready to handle 250 psig at operating temperatures up to 900 degrees F. Because it is pilot operated, it's easy on current drain, and it can be supplied to fail safe open or closed. Below . . . some of its distinguished colleagues. If you don't see the one for your requirement, let us know. We're always happy to add to this family.

HYDRO-AIRE
BURBANK, CALIFORNIA
Anti-Skid Braking Systems • Fuel System Controls • Pneumatic Controls • Actuation Systems
Electronic Devices

Producing Controls for Every Basic Airborne System

What's new in TITANIUM alloys:

Advances in aviation technology have happened so swiftly that engineering materials can no longer be selected for their broad use, but rather for the specific tasks they perform.

Today, in the face of tight budgets, the *right* material is the only sound solution to any given problem. Patch-work design, engendered by second-best materials, can only result in second-best aircraft and missiles in uniquely critical times.

To meet the constant tightening of design requirements, Titanium Metals Corporation of America has opened wide new areas of alloy development. This means: heat-treatable bar stock with *guaranteed* capabilities; higher temperature ceilings; broad new strength ranges.

Q. Are the guaranteed heat-treat alloys new?

A. The alloys are not. They have a production history of four years and a wealth of technical data to support them. Recent development of their full heat-treat capabilities has produced such dramatic results that they are considered new.

Q. What are the heat-treat alloys?

A. Ti-155A (5.5% aluminum; 1.5% iron; 1.5% chromium; 1.1% molybdenum) the highest strength bar and forging stock commercially available; and Ti-6A1-4V (6% aluminum; 4% vanadium), which in the annealed condition has already won wide designer confidence. Samples of *guaranteed* minimum heat-treat capabilities show:

	Ti-155A	Ti-6Al-4V
Section size: Up to 1″		
Ultimate Tensile Strength (psi)	170,000	160,000
0.2% Yield Strength (psi)	155,000	150,000
Elongation, % in 4D (Long)	10	10
(Trans)	8	8
Reduction in Area, % (Long)	20	25
(Trans)	15	20

Detailed information on Ti-155A is presented in a 20-page TMCA Engineering Bulletin. Additional data on Ti-6A1-4V, such as fatigue characteristics and guaranteed heat-treat capability are also available.

Q. Are there other new alloys?

A. The leading alloys nearing commercial volume are Ti-8A1-1Mo-1V, a bar stock offering excellent elevated-temperature creep strength to 1000°F, and Ti-4A1-3Mo-1V. The latter, now being produced and evaluated by the Department of Defense sheet rolling program, is designed to fill the need for high strength sheet alloy which can be formed in solution-treated condition and aged to strengths of 175,000 psi. When compared to other high-strength titanium alloys, Ti-4Al-3Mo-1V combines improved formability with outstanding elevated-temperature strength and stability.

Typical Properties — Ti-4Al-3Mo-1V

Condition	Temp. °F	0.2% YS psi	TS psi	Elong. % in 2″
Solution treated	Room	94,000	135,000	14
Solution treated and aged	Room	163,000	175,000	5
	200	142,000	169,000	8
	400	126,000	152,000	8
	600	111,000	140,000	7
	800	98,000	127,000	9

Q. How will these alloys raise temperature limits?

A. Ti-8Al-1Mo-1V is a good example. Although its short-time elevated temperature tensile properties are similar to Ti-6A1-4V, this new alloy offers as much as a tenfold increase in creep strength between 600°F and 1000°F, as shown:

Creep Comparison Between Ti-8Al-1Mo-1V and Ti-6Al-4V

Alloy	Annealing Treatment	Temp (°F)	Stress (psi)	Time (Hrs.)	Def. (%)
Ti-8Al-1Mo-1V	1400°F (24 hrs) AC	850	50,000	300	0.42
Ti-6Al-4V	1300°F (2 hrs) AC	850	50,000	300	3.6
Ti-8Al-1Mo-1V	1400°F (24 hrs) AC	950	15,000	300	0.16
Ti-6Al-4V	1300°F (2 hrs) AC	950	15,000	300	4.3

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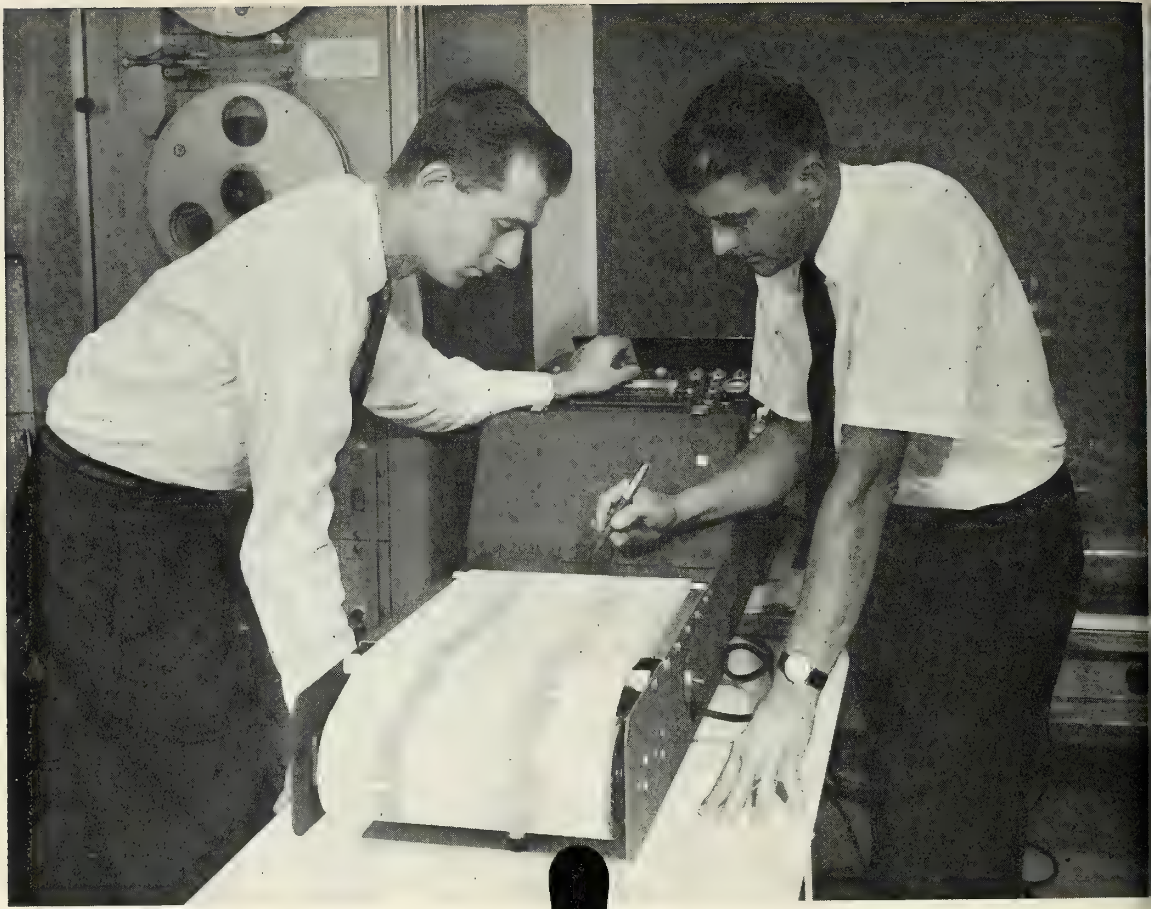

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COVER: *Use of plasma torches for fabricating shapes and applying coats capable of withstanding temperatures above 5,000 degrees F, is gaining momentum. Here, a nozzle liner for a rocket engine is formed from tungsten with a Linde Co. plasma torch. (See page 26).*

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in this issue

DECEMBER 22 HEADLINES

USSR May Have Tested Atom Rocket
Flyable prototype may generate 50,000 pounds of thrust, but Soviet wants 2,200,000 pound thrust engine by 1962 13

Budget Outlook: Program Stretch-Outs
Missiles and space hardware and R&D could reach $6.8 billion, with high emphasis on *Polaris, Minuteman, Pershing* 15

France Plans New Generation of Missile Warships
Missiles will replace artillery as anti-aircraft weapon 17

U.S. Lags in Using Stamps to Propagandize Astronautics
But Soviets and other Communist nations have many issues all extolling USSR as the 'Peaceful' world power 18

ASTRONAUTICS ENGINEERING

U.S. Planning Manus for Equator Launch Site
Multi-million dollar expansion of PMR is proposed for astronautics with Pacific islands to be instrumented for tracking 20

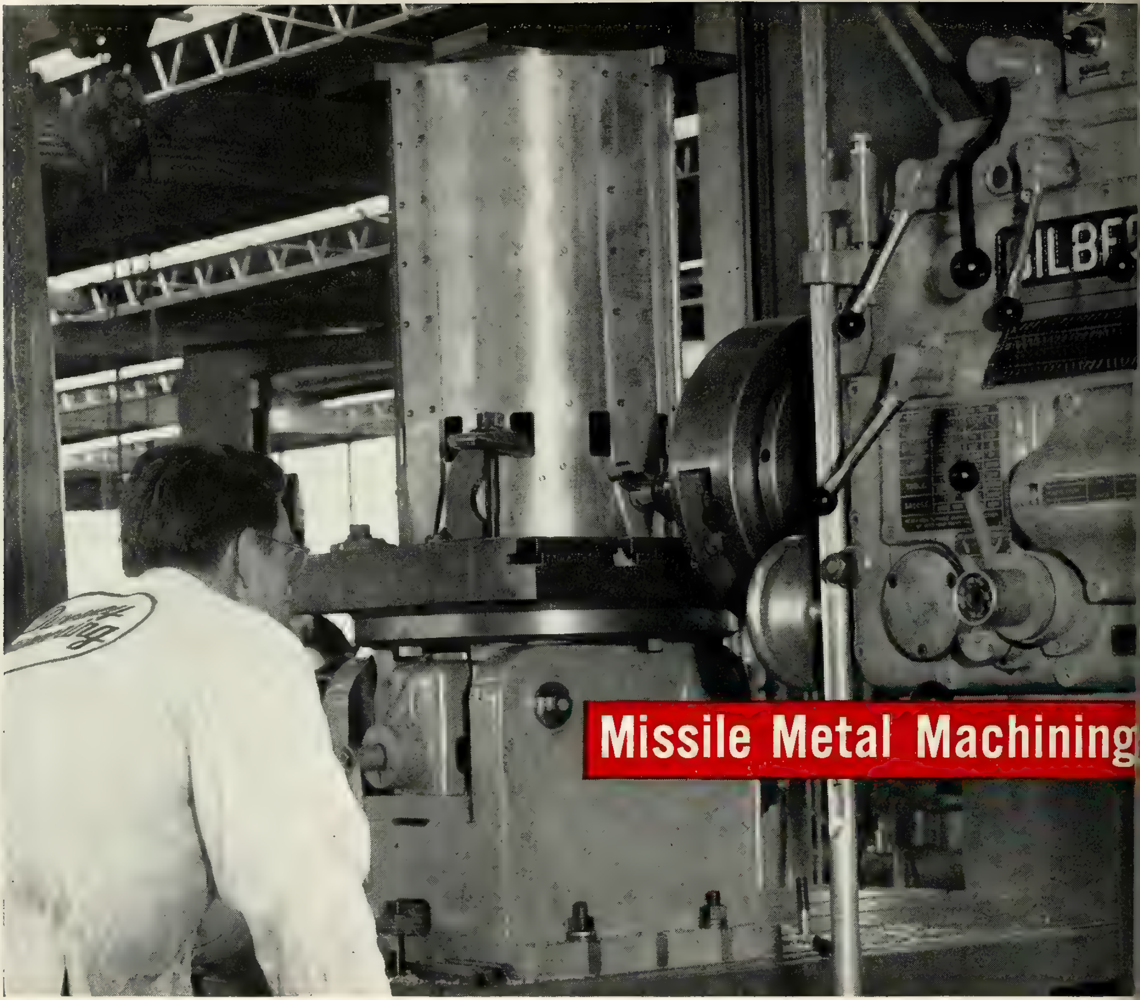
Dr. James R. Killian: Science 'Mystery Man'
Little is known of this advisor to the President whose influence is evident in the nation's astronautics program 22

MISSILE ELECTRONICS

New Plasma Tools Handle Ultra-Hard Metals 26
Synthetic Quartz Crystals in Pilot Production 31

DEPARTMENTS

In My Opinion 7
Washington Countdown ... 9
Industry Countdown 11
Propulsion Engineering ...33
Contract Awards 34



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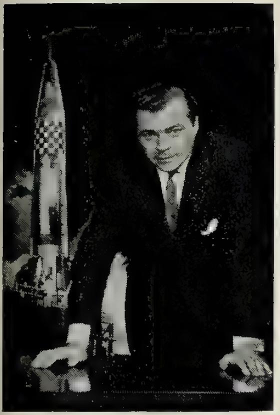


In My Opinion . . .

. . . the United States and the Soviet Union are now quietly waging an atomic rocket battle behind heavy security that may well shape the future of the free world (see story on page 13). But once again the U.S. is falling behind, and even extra funds and personnel probably will not speed the program.

The truth: Both nations' programs are startlingly similar in design, but it is in details that vast differences are noted. Present status: The Reds are believed to have tested a nuclear rocket engine of about 50,000 pounds of thrust, while the U.S. *Kiwi-A*—slated for a first test next month—will generate a maximum of 5,000 pounds thrust. Furthermore, in the third *Kiwi* model, total thrust will be 100,000 pounds, while the Soviets are striving for a 2,200,000 pound thrust nuclear engine by 1962.

The United States now—in the belief of many scientists—is taking an ultra-conservative approach on a fairly small scale. This despite the fact that the U.S. and the USSR both began active experimental atomic rocket propulsion programs about the same time—1955.

While the atomic Energy Commission is only now readying its first static test reactor, *Kiwi-A*, the USSR—many U.S. nuclear scientists believe—have already passed this stage.

Worse, the Russians are taking an experimental approach that might readily be translated into a piece of missile or space hardware.

The United States is moving slowly—apparently geared to grinding out data rather than flyable hardware. First U.S. step is a "dry" reactor—that is, a reactor from which heat output, radiation, and control characteristics can be gleaned. This is the much heralded "static" test.

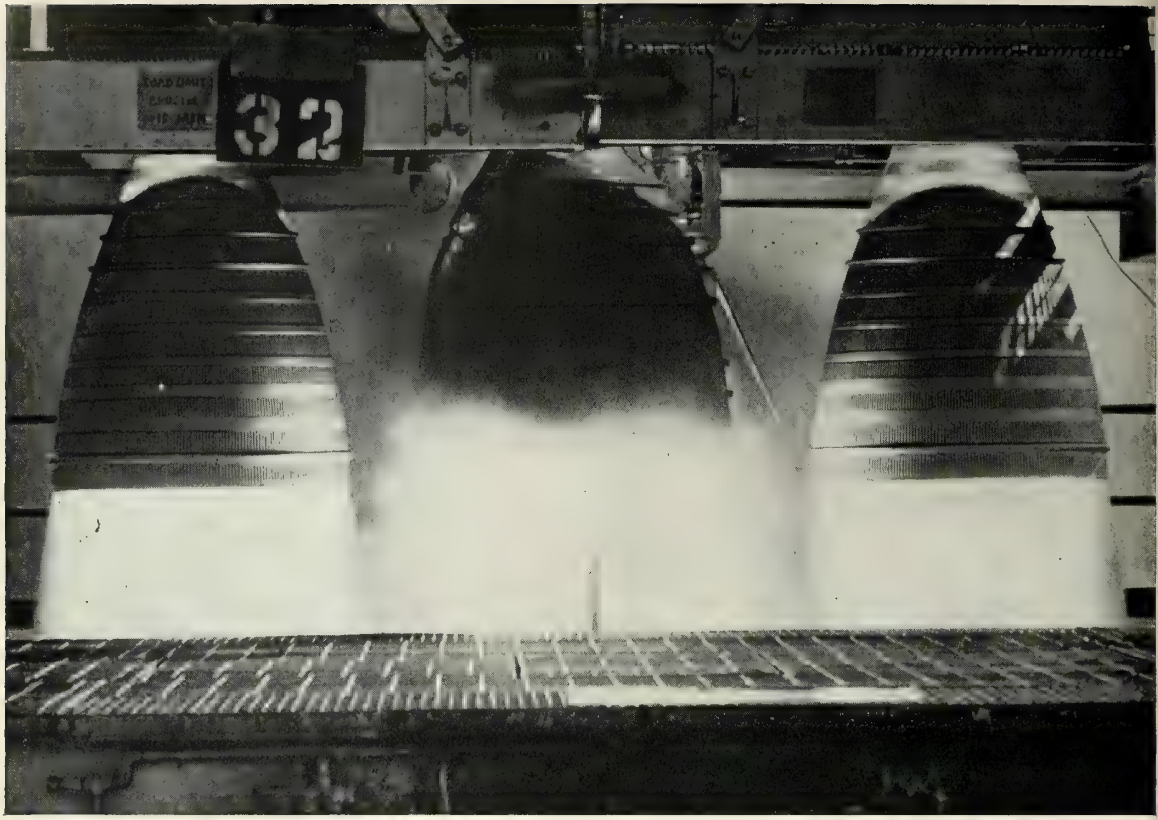
Provided AEC can get the pile to stay together—and this will be most difficult because it will attempt operation at about 3,000°F, or about twice that of present nuclear reactors, AEC will then start tests by forcing gaseous working fluids through it, with hydrogen or helium considered as the best bets.

But these gaseous flow tests, conducted by AEC's Los Alamos Scientific Laboratory on the Nevada test site, will be limited in operating time—now pegged at about five minutes.

The USSR program—to the contrary—apparently is sufficiently advanced to be geared directly to work with liquids first. Obviously, the Reds are aware that this country is trying hard to close the gap. So the Russian nuclear rocket crash program is proof the Communists won't permit their scientists to rest on *Sputnik* laurels.

This is a clear warning to this nation that we must continue pushing—and from the top—our own atomic rocket program with energy and consistency. The free world still has not recovered from Soviet gains in conventional chemical rocket propulsion. A victory in the atomic rocket race could well be the bridge for intended Soviet plans of world dominations.

Erik Bergaust



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washington countdown

A severe economic dip . . .
is feared by Brevard County, Fla. residents living near Cape Canaveral, if new Pacific Missile Range facilities take over some Cape functions and draw federal money away. DOD, however, says Vandenberg will compete with no other installations, and will complement them.

***Polaris* firings are good . . .**
says Rear Admiral W. F. Raborn. Some 21 out of 24 were successful. One failure preceded 21 successes, followed by two more failures. Seven shots were made this year. Raborn says the last failure was caused by the premature activation of a minor destruct system which would not be incorporated in the operational missile.

Dollar scarcity . . .
competition battle is looming between the Air Force and Navy over each service's major war deterrent capabilities. The Navy wants SAC funds passed to the *Polaris*. It is a battle that will increase in intensity as the advocates of the forces in being compete with the forces of the future.

***Bullpup* may go to Italy . . .**
according to reports from Rome where studies are underway. The Fiat G-91, may be equipped with the air-to-surface missile.

British satellite . . .
launching and re-entry techniques leading to a possible manned satellite are being studied by Britain's Armstrong-Whitworth.

Defense department is concerned . . .
with the failure to find a country which is willing to install *Jupiter*. Defense Secretary Neil McElroy is conferring with Italian officials in the hope of installing 45 *Jupiters*.

Army is moving ahead . . .
with its big solid propellant *Pershing* with the letting of a $2 million contract for construction of test facilities at Cape Canaveral.

Breakthrough in photographic . . .
detection and recording satellites in space has been achieved by NOTS at China Lake. Known as a "synchronized smear camera," the device is capable of obtaining exposure as long as 10 minutes on a satellite. A network of nine of these cameras reportedly can cover the sky from horizon to horizon maintaining "photographic watch" for as long as three hours at a time.

U.S. military thinkers . . .
doubt reported 8,700 mile range ICBM gives the Soviet any new advantage. DOD points out a 5,000-mile missile fired over the pole can hit any point in U.S. but increased range would permit Russia to locate bases further south, which would be an advantage. But increased range carries with it increased guidance problems and greater CPE.

High-altitude launch sites . . .
are reported being built by Russia in Tibet. This could provide advantage in missile and satellite firings as half the weight of the earth's atmosphere is below 15,000 feet. Such bases would indicate distinct Russian advances in solid propellant rockets.

New Congress . . .
should be liberal minded when it comes to spending, with its majority of Democrats. However, in preparing briefings for the lawmakers, military planners are not forgetting there will be many newcomers to the Hill and many probably will bring with them a "show me" attitude. In the House there will be 63 new faces, three of whom have served previous terms. In the Senate there will be 18 new Senators including two from Alaska.

Eisenhower wrote the ticket . . .
which sent the first Western primate into space. The decision to send aloft in a tactical *Jupiter*, the squirrel monkey, "Gordo," was made the afternoon before the early morning launch.

ROUNDUPS COMING: *Next week, m/r will feature missile and astronautics progress during the past calendar year. The January 5 edition will be a preview of what the new Congress can be expected to do in legislation affecting the industry. Watch for these articles.*

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industry countdown

Redstone Arsenal . . .
will undergo extensive research and development expansion as the result of contract awards from the Corps of Engineers. Pearce and Gresham Co. of Decatur, Alabama received contracts totalling $2,103,199 for Redstone Arsenal construction. One contract provides for a preflight evaluation laboratory at a cost of $1,060,947 and the other for $1,042,252 calls for construction of propellant development facilities.

High energy liquid engines . . .
are being sought for second stage systems in ARPA's ICBM research rocket test vehicles, according to the agency's chief scientist, Dr. Herbert York. Reference was apparently made to the Project *Discoverer* and Project *Midas* satellites planned for late 1959 or early 1960, recently disclosed by agency head Roy Johnson. Two firms have been mentioned as potential suppliers of such systems. Bell Aircraft has developed a HEF rocket engine for the second stage of the first *Discoverer* shots (m/r, Dec. 15, p. 18) using fluorine as propellant while Pratt and Whitney holds a development contract for a high energy rocket engine for the second stage of a later system.

Boron trichloride . . .
may soon reach manufacturing feasibility status. A joint venture to perfect an economic process for the manufacture of the boron compound, an intermediate from which most of the newer and more exotic compounds are made, has been initiated by the Dow Chemical Co. and U.S. Borax Research Corp. Both companies have conducted individual research in this field for several years. Boron compounds have potential and actual uses as catalysts, high temperature polymers, high energy fuels for rocket (solid and liquid) and jet engines, gasoline additives, metal refiners, and fluxes.

Unobserved observer . . .
device has been patented by an arm of the Singer Manufacturing Company's Military Products Division. The system employing infrared radiation to make the original detection and determine the direction of the object observed, permits the searcher to operate unobserved during this phase of the search. Once the object is discovered and its direction is determined, a series of radar pulses obtain the range. Electronic countermeasures of the enemy are given minimum opportunity to detect the observer because of the slight duration of the radar operation.

Controlling interest . . .
of Research Communications, Inc., consultants to the astronautics industry, has been acquired by the Turbo Dynamics Corp. research and development firm of Los Angeles.

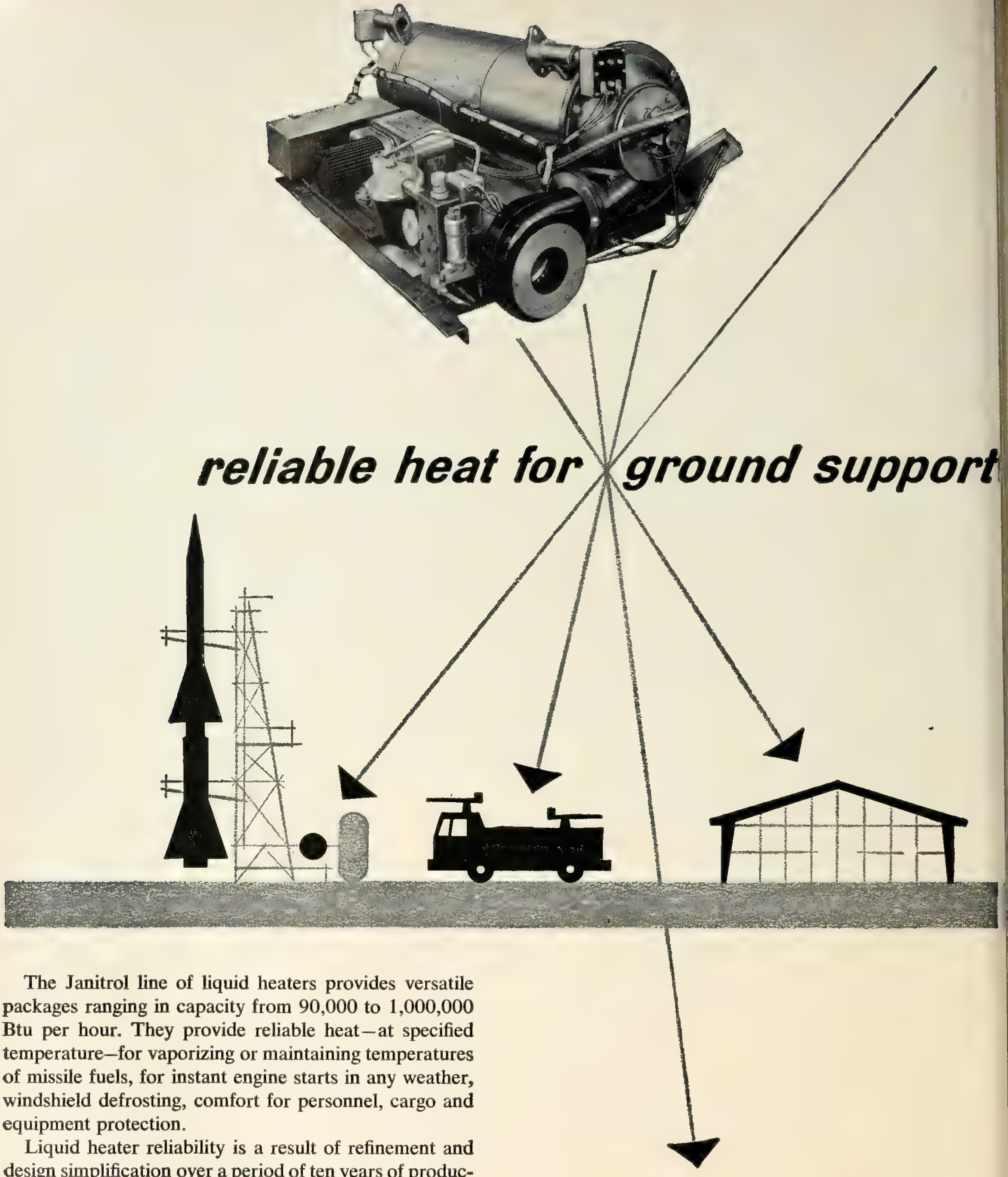
Washington trade-association . . .
executives, recently polled on the treatment they think business will get as a result of the election of so many liberal new lawmakers, were quite calm about legislative prospects for 1959 and 1960. Those polled don't anticipate persecution of business by the New Deal-Fair Deal Democrats on Capitol Hill. Labor may in fact be able to secure an increase in the minimum wage to $1.25 an hour and Congress will probably pass the Kennedy-Ives bill with revisions in the Taft Act more likely than at any time since its passage.

AVCO's latest division . . .
located at Nashville, Tenn., will be engaged in engineering and production of aircraft and missile structures and assemblies, stainless steel honeycomb panels, and components for radar systems.

***Atlas* guidance computer . . .**
delivery to the Air Force from Burroughs Corp. was followed by two additional contract awards totaling $22,448,568 for more equipment. Latest computer is more sophisticated than previous models, is easier to maintain and has higher reliability capabilities. The two awards brought Burroughs total backlog for *Atlas* computers to $68 million.

Vandenberg's three-pad *Atlas* . . .
complex has an estimated construction cost of about $15 million, according to Army Corps of Engineers. With $50 million for the base construction already contracted, it is estimated that $120 million will be spent in the next three years. Packard-Bell Electronics Corp. has installed 110 items at Vandenberg at a cost of $1 million. Ultimately, $400 to $500 million will be spent on electronic gear by various missile sites in the Pacific Missile Range, according to information received by Packard-Bell.

reliable heat for ground support



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DECEMBER 22, 1958—VOL. 4, NO. 25

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

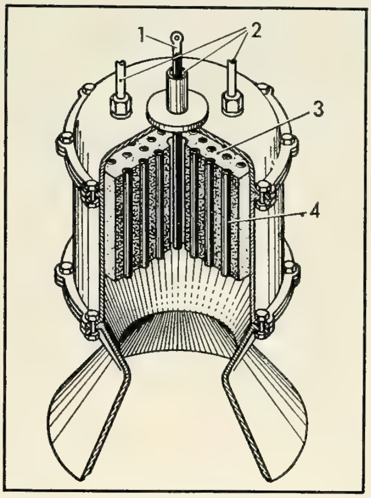
USSR May Have Tested Atom Rocket

by Alfred J. Zaehringer

DETROIT—The Soviet Union—m/r has learned from usually reliable sources—has reportedly tested an ultimate flyable prototype of a nuclear rocket engine of 50,000 pounds thrust, and has set a development goal of a 2,200,000 thrust nuclear rocket engine by 1962.

In contrast, the United States will make the first so-called "static" test next month of *Kiwi-A*, which is not designed to be the prototype of a flyable reactor, and ultimately will generate only 5,000 pounds of thrust in the first version. *Kiwi-C*, the third version, again not flyable, will generate 100,000 pounds of thrust.

M/r is unable to determine with any degree of certainty where the USSR is conducting its nuclear rocket tests, but they have to be bifurcated from conventional test complexes because of the inherent radiation hazards. Probable regions are Arctic Siberia or the extreme Southern desert regions.



PROBABLE RUSSIAN atomic rocket. 1. Control shaft, 2. Hydrogen pipeline, 3. Graphite, 4. Rods of U235.

• 100 ton goal—The Soviet goal is an atomic rocket weighing close to 100 tons and having sizeable payload characteristics. The USSR program is geared directly to the use of liquids from the start—probably liquid hydrogen. Thus when they finish their current test program they will have a scalable prototype.

The United States, on the other hand, is moving first with a "dry" reactor—that is a reactor from which heat output, radiation, and control characteristics can be gathered. This is the heralded *Kiwi-A* "static" test, which poses at least one almost insurmountable problem: getting the pile to stay together. This is because attempted operation will be at about 3,000°F—or about twice that of present nuclear reactors.

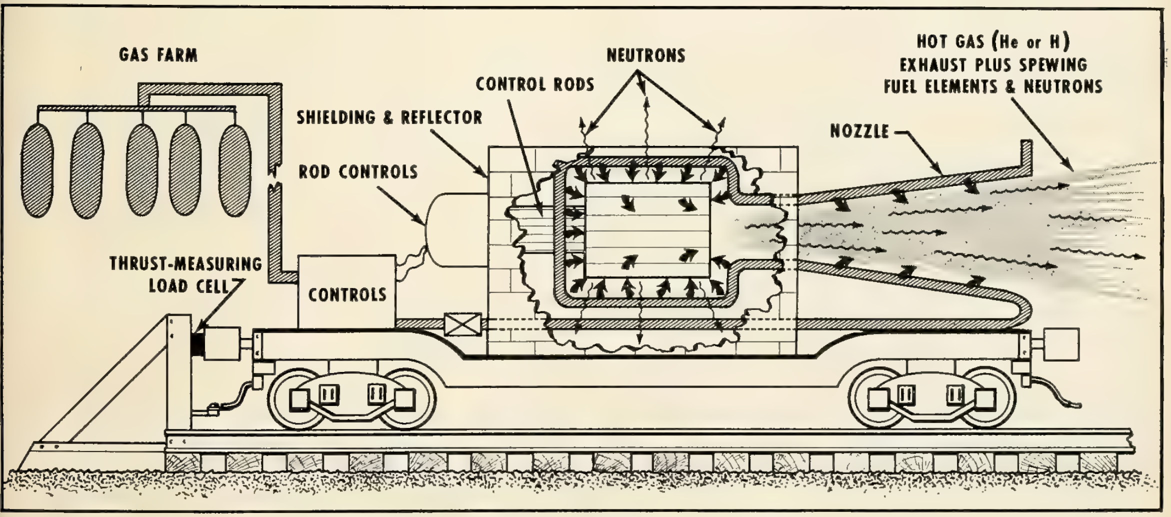
If this problem can be overcome, the next step will be to force gaseous working fluids—as the Russians are currently doing—through the reactor. Hydrogen or helium are considered the best bets.

• Limited operating time—But these gaseous flow tests, conducted by the Los Alamos Scientific Laboratory at AEC's Nevada test site, will be severely limited in operating time—about five minutes.

The USSR nuclear rocket program is directly geared to its astronautical aspirations. The Astronautical Commission and the USSR Academy of Sciences, has representatives from the nuclear field. Noted among these is the Soviet atomic expert, Peter L. Kapitsa.

According to Fred C. Durant, noted astronautics worker, the role of Kapitsa is to advise the Commission on low temperature propellants (such as liquid hydrogen) and the use of atomic rockets.

It is significant to note that Academician Kapitsa, aside from his nuclear talents, runs a cryogenic lab and has done much work on the prop-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SCHEMATIC DRAWING of AEC's *Kiwi-A* nuclear rocket.

erties and handling of liquid hydrogen. The USSR Academy of Sciences also has a firm grasp on nuclear efforts since it runs the USSR Institute for Atomic Energy. The IAE may be similar to our own AEC in operation. However, the IAE is governed by scientists.

Thus, the Soviet atomic rocket program is seen to be in an extremely strong position when compared with America's atomic rocket project.

- **Here is comparison**—America's weak start is likely to be reflected in its technological pattern. It is now, for the first time, possible to compare both technical programs (see accompanying table).

The startling fact is that both programs are very similar in outline. It is in detail that vast differences are noted.

First, both countries will use the pile to replace the chemical combustion process by using heat released during fission to expand a working fluid.

From this point onward, there is a wide disparity in hardware attempts. The Soviets are clearly thinking big. Assuming equal talent, it would be possible for the Soviets to beat us to the punch since they are thinking toward the hardware of large rockets.

Two American aircraft firms have taken a look at the need for an atomic rocket. Rocketdyne, now building the nozzle for *Kiwi-A*, estimates that a compact liquid atomic rocket engine delivering, say, 100,000 pounds of thrust, could be put together readily. Convair-Astronautics' Krafft Ehricke has advocated the use of a nuclear rocket using liquid hydrogen working fluid for various space missions.

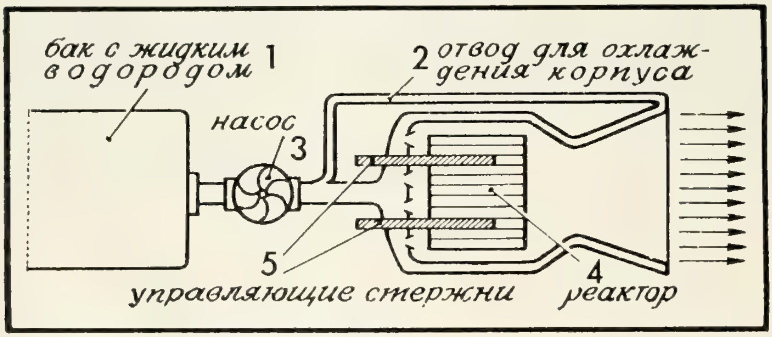
Another potent problem concerned with the atomic rocket is takeoff. The atomic rocket engine may never be able to come up to full thrust and temperature like the milliseconds of conventional chemical engines. Therefore, most U.S. thought seems to be to boost the atomic rocket with chemical rockets. This also solves some of the radiation problems.

However, the USSR has been doing much design work with mixed powerplants for the atomic powerplant. Goal: to combine the nuclear power plant with chemical systems to give returnable, manned satellites and space probes.

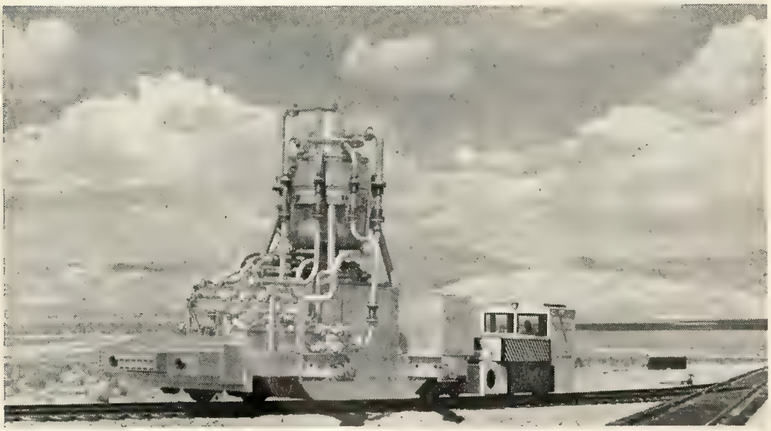
The next Soviet satellites might conceivably be heavier by use of the megapound chemical engines now under development. However, large manned satellites and moon expeditions will probably come hard on the heels of the megapound thrust atomic engine now being aimed for in the Soviet Union.

The Atomic Rocket Engine
US versus USSR
(Estimated)

PARAMETER	USA			USSR		
	KIWI-A	KIWI-B	KIWI-C	TEST	PROTOTYPE	PRODUCTION
Fuel Element	90% U-235	Enriched U-235		U-235/ U-238	90% U-235	enriched U-235
Cladding	Metal?	Ceramic?		Metal?	Ceramic?	
Neutron Moderator	Graphite?	?		Graphite	Other	
Coolant	He or H gas	liquid H or hydrocarbon		Liquid H		
Reactor Temp. (F)	3000	3600		3600	7200?	
Operating Time (minutes)	5			6	6-10	
Thrust (lb)	5000	50,000	100,000	50,000	100,000	2,200,000
Reactor Wt. (lb)	10,000-15,000		15,000	30,000	20,000	20,000
Diameter (ft)	5					
Length (ft)	10		6.0			7.7
Isp (sec)	300	550	790			710
Date	1959	1962	1965	1959	1961	1962



'FLUID REACTIVE' Russian engine probably works like this. 1. Hydrogen tank, 2. Regenerative cooling line, 3. Pump, 4. Reactor, 5. Control rods.



READY FOR tests on the Nevada proving ground of AEC, is *Kiwi-A*, shown on its railroad car. *Kiwi* is part of the *Rover* program.

Budget Outlook: Program Stretch-outs

Missiles and space hardware and R&D could reach $6.8 billion of $41 billion-plus defense budget. ARPA's budget should approximate half billion. High emphasis will continue on *Polaris, Titan, Atlas, Minuteman.*

by William O. Miller

WASHINGTON—Continuing the upward trend of the last few years, it is more than likely that the U.S. military budget for missiles and space equipment for Fiscal Year 1960 will well exceed the $6.8 billion mark.

As the largest spender of the three services, the Air Force has shown a steady trend toward missiles and away from manned aircraft. So have the other services. These are comparative Defense Department figures for procurement and production:

	Fiscal 1958	Fiscal 1959
Aircraft	$8.4 billion	$7.2 billion
Missiles	$2.7 billion	$3.4 billion
R&D	$1.7 billion	$2.4 billion

Funds for missiles and space projects this fiscal year should approach $4.3 billion for production and procurement; $1 billion for construction, and $1.5 billion for research and development.

Not included is the $420 million budget of the Advanced Research Projects Agency for 1958 (its first year) of which, ARPA's officials estimate, probably two-thirds or some $300 million went for missilry. ARPA's 1960 budget should approximate $500 million. NASA's non-military budget may approximate $500 million.

- **$41 plus billion budget**—Last year's overall defense budget, not including foreign aid, was $40.9 billion. Estimates for this year—taking into account the Russian threat and the temper of an overwhelmingly Democratic Congress—range from $42 billion to a more likely $41-plus billion. Under any trend it is highly unlikely the increase in missile procurement will be under the 25% increase of 1959 over 1958.

Individually, the services, rate their missile programs about as follows:

Air Force

The Air Force budget for Fiscal Year 1959 was $18,662 billion plus $785 million construction funds. It is expected to be about the same this year. Added to this will be a carryover of several billions from last year. Of these two figures, the Bureau of the Budget and Department of the Defense will tell the Air Force how much it can obligate in contracts and also how much it can actually spend. Working under the assumption that both obligating authority and spending cash will be about the same in Fiscal 1960 as in Fiscal 1959, the USAF missile program shapes up in this fashion:

Dyna-Soar: Limited funding for this boost-glide man-in-space concept. Design competition is between Martin and Boeing with systems management contract due in late Spring. Development progress will be slow because the system requirement exceeds present and near future state-of-the art.

Minuteman: Firm funding with stepped up development. Boeing is assembly and test company for this advanced solid propellant, hard-base ICBM. System still faces problem on whether adequate guidance and propellant can be wrapped in the projected small package. *Minuteman* is intended for mass production, wide dispersal, medium warhead and is not at the moment considered competitive or supplanting the *Titan.*

1000-mile air-to-surface missile (WS-199B): Limited funding. Lockheed and Martin are working in design competition. Early tests have gone well, although a number of stability problems have cropped up unexpectedly. Test hardware near final configuration expected in about one year. Good bet for more volume production.

Discoverer: Money is in the bag on this Lockheed outgrowth of the old reconnaissance satellite project. It is now intended to investigate many scientific space problems, including those necessary for recon capability. *Thor* and later *Atlas* will be used as boosters.

Atlas: Well funded although far from Convair's possible production capacity. Latest tests of this ICBM have gone well and missile has many potentials although still not yet completely proven.

Titan: Money is firm for this Martin ICBM and it is on schedule. *Titan,* while a year or more behind *Atlas,* is designed for hardened bases and AF believes *Titan* will be operational before *Atlas* could be converted to hardened launch capability. Also *Titan's* two stages give it greater potentials over stage and half *Atlas.*

Thor (Douglas) and *Jupiter* (Chrysler): Production on both these IRBMs will probably be cut off within a year, at end of present limited schedule. DOD feels there is no use for them. England is getting up to four squadrons of *Thors.* Other foreign commitments are solely up to NATO with only one country under serious negotiation for the *Jupiter.*

Falcon: Limited funding for this air-to-air missile. *Falcon* does not adapt well to nuclear warhead, now deemed essential. Worthwhile features may, however, be mated with *Eagle.*

White Lance: Limited funding also for this nuclear warhead air-to-surface tactical missile. AF is having trouble converting it from Navy version *Bullpup.*

Genie: An interim nuclear weapon but the air-to-air weapon will be well funded until something better comes along with atomic warhead.

Bomarc: Strong funding for this ground-to-air interceptor. The Boeing *Bomarc A* (250 mile range) scored eight out of eight on latest tests. *Bomarc B* (400 mile range) is due in about a year.

Hound Dog: Well funded and doing well. Will definitely continue as strategic air-to-ground missile until it is succeeded by a longer range version. Continued production at North American scheduled.

Snark: Funding probably limited to one announced squadron of this air-breathing ICBM. After looking well proven, has been having troubles lately.

Goose: This air-breathing ICBM decoy has just been cancelled.

Army

The Army asked for and received $8.9 billion dollars in the Fiscal 1959 budget. Indications are that this year's budget will be about the same. Chief of Staff Maxwell Taylor has estimated that modernization of the Army will cost about $3 billion a year for the next five years.

While no definite figures as to numbers or amounts are available, Army thinking as to emphasis or de-emphasis in the event of a cut looks like this:

Corporal: Probably will be in for

some cut. It's an older missile system and Army looks to *Sergeant* to replace it. No development money in *Corporal* but spares and replacements are required in some equipment, especially radar.

SS-10: Has high priority as replacement for *Dart*. Most important weapon in anti-tank area, not only to Army but also Marine Corps. Would not be touched if cuts come.

Honest John: Possible but not probable reduction. Now operational and well integrated into all divisions. Improvement program now underway. Troops in field are familiar with and know how to use. Most future expenditures for improvement of range and efficiency which Army knows how to attain.

Little John: Possibly could be cut back, but is important weapon to Army's STRAC forces. Needs very little more development money. Definitely will receive emphasis in form of improvement program.

Lacrosse: A very accurate close support weapon but may be considered for cut back in numbers produced.

Redstone: Further production and procurement of extensive spares and improvement unlikely. Army looks to forthcoming *Pershing* to do the same job a lot better and easier.

Nike-Zeus: Has one of the highest priorities and would not be cut. Not only an anti-ballistic missile but could be used against aircraft targets.

Nike-Hercules: Out of development stage and would not be involved in cuts. Overall cost has been less than might be expected because of previous work on *Ajax*.

Pershing: Will receive emphasis and cuts should not involve it. Solid motor and mobility capability makes this highly desirable from Army viewpoint.

Hawk: Definitely will receive emphasis in any budget. High degree of mobility appeals to Army.

Redeye, Mauler, Missile Able: All in feasibility study stage. While Army does not want funds cut, admits feasibility area good hunting place for budget cutters who feel work can proceed with less money. Army fears cuts will dangerously delay availability.

• **Guide line**—Army planners readily admit the one guide line for any reduction or emphasis is how the weapon fits into plan for support of the land battle. Basic mission is for utilization in the field and rapid development of the battlefield mobility concept. Army, like other services, would implement cutbacks in numbers of various missiles rather than elimination of complete systems.

Navy

Navy missilemen are putting up a hard fight for more money, suggesting that some of these funds can come from SAC funds which they believe is being outdated by *Polaris*. Not only would Navy like some of the AF money, but within Navy itself, there is a hot controversy between the airmen and the missilemen as to relative importance of the two. Missilemen say they want to give the airmen better weapons for their aircraft, while the airmen want more aircraft. Missilemen say that if their viewpoint doesn't win out, equipping of present and additional Navy aircraft could deplete back-up supply and empty magazines.

Again, actual numbers are not available, but emphasis would be placed on certain systems in the event of a cut. Navy also would try not to eliminate any specific system, but would cut back in numbers ordered and slow up on feasibility and development and research.

Polaris: Has highest of priorities and would not be bothered by a cut. Funds for four FBM subs still being held up by DOD.

Bullpup: Expected to be operational in fleet by next year. Actual numbers ordered might be curtailed, but Navy is worried about a back-up supply.

Sparrow III: Now operational in fleet. Production quantities might be reduced as number of squadrons increase. But it will receive definite emphasis in view of its all-weather capability.

Sidewinder: Navy wants to put it in all fighters. Many aircraft utilize *Sidewinder*, but can't use *Sparrow III*. Again, total production numbers might be cut.

Regulus I: Definite phase out.

Regulus II: Will receive emphasis in view of nuclear submarines use. Plans are that boats originally slated to use either *Regulus I* or *II* will now use only *Regulus II*. Cruisers, including new construction, can employ missile.

Terrier: Operational, and only way a cut could be effected would be in stretching out production numbers.

Tartar: Has high priority and will receive emphasis. Undergoing developmental evaluation. This semi-active guidance missile provides new construction destroyers with important low-altitude capability.

Talos: Now operational, but total production numbers may be cut in view of anticipated improvements. Size presently permits use only on cruisers.

Rat: Cancelled in favor of *Asroc* which will receive emphasis.

Subroc: Has one of highest priorities. Still undergoing development. Contract went to Goodyear about six months ago. Some of money which was cut during present year has been reprogrammed into the project.

Sparrow I: Being phased out.

Eagle: Navy's latest air-to-air long range defense. Has one of highest priorities. Emphasis will be on missile rather than aircraft used to launch. Would not be affected by cut.

Corvus: Air-to-surface-being developed by Temco. Undergoing development with availability anticipated in 1962. Receiving emphasis.

Feasibility and development studies could be slowed by, but no eliminations can be expected on various follow-up programs.

Astronautics Tests

This is the week's summary of missile and space experiments:

1) Dec. 10—*Regulus II* launched from LST. Mission completed.

2) Dec. 11—*Snark* made round-trip flight from Cape Canaveral. Mission completed.

3) Dec. 11—*Regulus II* launched from Mojave Desert on inland range for 750-mile flight. Mission completed.

4) Dec. 13—*Jupiter* fired over 1500-mile with "Gordo" squirrel monkey in the nose cone. Payload impacted within the target area but neither cone nor monkey was recovered.

5) Dec. 13—*Bomarc* sent 250 miles against F-80 target drone. Mission completed.

6) Dec. 16—Air Force was to have fired first *Thor* from Vandenberg at 12:20 p.m. (PST).

Here is a summary of space animal experiments.

1) 1953—Air Force fired two monkeys to an altitude of 200,000 feet in *Aerobee* rocket.

2) November 3, 1958—Laika orbited the earth aboard *Sputnik II*. Lived for seven days.

3) April 23, 1958—*Thor-Able I* with mouse aboard traveled at least 1500 miles. No recovery.

4) July 9, 1958—*Thor-Able II* traveled 6000 miles. Mouse aboard. No recovery.

5) July 23, 1958—*Thor-Able III* traveled 6000 miles. Mouse Wickie aboard. No recovery.

6) August 27, 1958—Soviets sent two dogs 281 miles above the earth and returned them safely.

7) Dec. 13, 1958—*Jupiter* went 1500 mile range with peak 300 mile altitude with monkey aboard. No recovery.

Maruca, **ship-to-air, is formidable addition to French Navy.**

Masurca **is another addition to the French naval arsenal.**

New Warships Planned for French Missiles

by Jean Marie Riche

PARIS—When the French Defense Minister, Pierre Guillaumat, went to Toulon at the end of October to visit top secret facilities of the French Navy, the veil was lifted for the first time on the plans and activities of the Marine Nationale in the missiles field.

Since 1950, the French Navy has been engaged in a program whose fruits were to grow and ripen in a period of about 10 years. A "Groupe Technique des Engins Speciaux" (Technical Group for Missiles) was created at the Arsenal of Toulon, the main base of the French Navy. Purpose: to back a test-range installed on the nearby Ile du Levant, a five-mile-long island whose shooting range extends about 30 miles over the Mediterranean to the southeast. This range is called "Centre d'Essais et de Recherches d'Engins Speciaux" (C.E.R.E.S., Test and Research Center for Missiles).

In 1952, personnel at the center began training with ARS 5501 target missiles which have now been replaced by CT 20 missiles produced by SNCA du Nord. In the version delivered to the Navy, these missiles are especially equipped to float after being shot down.

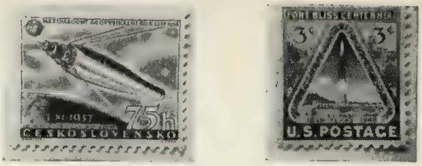
In 1957, the first subsonic training ship-to-air missiles *Maruca* became operational and regular firings began. It was from those missiles that the Arsenal of Ruelle developed, in liaison with the Direction des Etudes et des Constructions d'Armes Navales, a supersonic ship-to-air weapon, the *Masurca,* which the French Navy compares with the *Terrier* and which is guided by a semi-active homing system. Further, a pilotless interceptor—the *Masalca*—also equipped with a semi-active homing

(Continued on page 32)

Missiles in the French Naval Arsenal

DESIGNATION	SS 11	MALAFACE	MASALCA	MASURCA	MARUCA
TYPE	Ship-to-Ship	Ship-to-Ship	Ship-to-Air	Ship-to-Air	Ship-to-Air
MANUFACTURER	Nord-Aviation		Latecoere	Ruelle Naval Arsenal	Ruelle Naval Arsenal
LENGTH	4' 0"	20' 8"		18' 8"	15' 1"
SPAN		8' 6"		3' 3"	5' 3"
WEIGHT				2205 lbs.	1015 lbs.
ENGINES	SPR			SPR	LPR
RANGE		25 miles	60 miles	Approx. 15 miles	11 miles 10 mile altitude
SPEED	430 mph			Supersonic	Mach 0.85
PAYLOAD		1545 lb. warhead			132 lb. warhead
GUIDANCE	Wire	Radar	Semiactive radar	Semiactive radar	Radar
REMARKS	Naval version of antitank missile, to be used against small craft and in support of landings.	May also be used against shore installations. Guidance is integrated with Maruca system. Antisubmarine version is known as Malafon.	Small missile intended for small warships.		Also used as experimental and training missile.

CZECHOSLOVAKIA ISSUED *Sputnik II* stamp for IGY, left. First rocket on a U.S. stamp commemorated the Fort Bliss Centennial, right.



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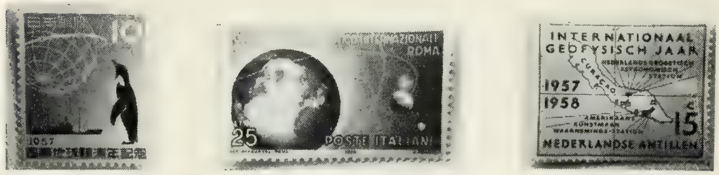
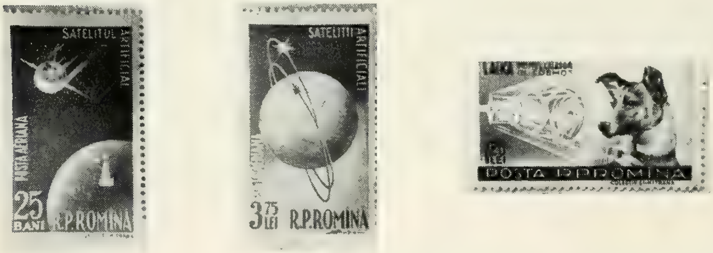
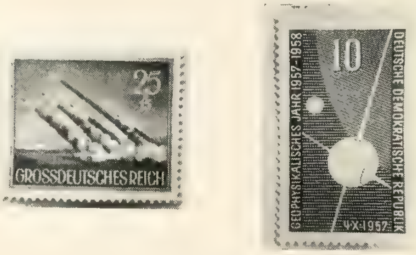


PENQUIN WATCHES orbiting satellite for another IGY issue, this time by Japan, left. Italy commemorated IAF meeting in Rome during 1956, in this first stamp to picture a satellite, center. Netherlands Antilles issue locates a U.S. satellite tracking station in Curacao, right.

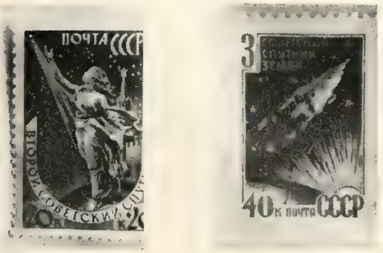


COMMUNIST ROMANIA pictures USSR satellite activities with *Sputnik I* orbiting Kremlin, left. *Sputniki* orbit world, center. Laika, the dog passenger in *Sputnik II*, right.

GERMAN WORLD WAR II printing shows artillery rockets in action, marking the first time rockets were illustrated on stamps, left. East Germany issue shows *Sputnik I*, right.



25
GROSSDEUTSCHES REICH
10
GEOPHYSIKALISCHES JAHR 1957-1958
DEUTSCHE DEMOKRATISCHE REPUBLIK
4.X.1957



ANOTHER RUSSIAN satellite issue is this *Sputnik II* allegory, left. Carrier rocket of *Sputnik III*, right.

by Alfred J. Zaehringer

DETROIT—Using stamps as parameters to indicate its international feelings, the United States is seen to lag badly in this vital area of ideological and propaganda warfare.

But the Soviet Union is using the time honored stamp to get across to other nations that it is a leader in peaceful rocketry and satellites. As the accompanying table indicates, the U.S. has only once in 10 years chosen to put a rocket on a stamp. This was the 3¢ Fort Bliss Centennial which showed, of all things, a rocket very greatly resembling a German *V-2*! On the other hand, Russia during the IGY issued eight stamps showing all three *Sputniki*, IGY rockets, plus a Ziolkowsky commemorative.

The USSR, however, was not the first to show a rocket on a regular stamp issue. During World War II, Germany issued a special stamp showing the employment of barrage artillery rockets. In addition to the stamps shown in the table, there have been other private stamps to commemorate rocket firings, rocket mail, and astronautical meetings. However, only stamps issued by the various world governments have been used in this comparison.

In 1955, Monaco issued a Jules Verne commemorative showing a moon rocket.

- **Italy first**—The first satellite stamp was issued by Italy in 1956 in honor of the International Astronautical Federation which held its meeting in Rome.

One of the most recent satellites on a postage stamp is the 1957 IGY issue by Japan which shows a penguin watching an orbiting vehicle. One of the most unusual rocket stamps recently issued illustrates the Japanese

g Stamps To onautics Work

Only once in 10 years has the nation put a rocket on a stamp, but Soviet uses stamps to extoll USSR as 'Peaceful'

pencil rockets (Ryukya Islands). Even the Netherlands Antilles has gotten into the stamp satellite business by issuing a map of the American satellite tracking station at Curacao.

The Republic of Haiti has even beaten the U.S. to the punch by issuing the first U.S. satellite to be shown on a stamp—the *Vanguard* "grapefruit."

Of course, various eastern European satellite nations have decided to ride on the merits and accomplishments of the Soviets. Romania has four issues—one extolls Laika as the first living orbiter. East Germany illustrates *Sputnik I* as an IGY accomplishment. Czechoslovakia not only shows *Sputnik II* but shows a large carrier rocket—which accurately corresponds to the 50-70 foot long rocket which has been theorized as a result of optical tracking data.

- **Eight Soviet issues**—To be sure, the Reds are not to be outdone for they have eight official issues. The first shows an IGY sounding rocket (resembling a worked over *V-2*). The second, celebrated the anniversary of Ziolkowsky. As a matter of fact, the first *Sputnik* came so close to the issue of the Ziolkowsky event that one may conclude that it was so planned. Anyway, the Russians merely overprinted the Ziolkowsky stamp with the launching date of *Sputnik I*. *Sputnik I* was heavily glamorized by the use of an allegorical female form—something unusual for the Russians. *Sputnik III* was pictured in fairly accurate detail in the last Russian stamp issue.

It is clear that the Soviets will use stamps for all they are worth in order to propagandize to the world that they are the new aggressive—and peaceful—world force. For example, the Soviets have recently issued a rocket-atom disarmament stamp. The U.S. occupies a back place in the satellite stamp field while the world knows it is spending billions on military missiles.

The Soviets never fail to blast this forth to the "neutral" nations—while the U.S. neglects to give proper credit to the personnel and accomplishments in peaceful research, particularly the IGY.

The U.S. now produces many new commemoratives each year—anywhere from five to 15—which usually conservatively extoll some dull fact out of the dim past.

From the standpoint of the present world struggle, the U.S. still apparently does not realize that you have to display democracy as a dynamic, relentless thing, not a portrait of the past.

It is certain that what the U.S. is now doing in missiles, rockets, and astronautics will certainly hold the key to the future. Stamps are only a small cog in the ideological battle now raging, and many observers feel strongly the U.S. is very deficient.

DATE	SCOTT CATALOG NO.	DENOM.	TITLE	COUNTRY
1944	B268SP221	25+15 pf	Artillery rockets	Germany
1948	976A423	3¢	Ft. Bliss Centennial	U.S.
1955	C45APZ1	200 fr	Verne's Earth-Moon Rocket	Monaco
1956	717A393	25 l	IAF-Satellite	Italy
1957	241A55	15	Curacao Tracking Station	Netherland Antilles
1957	637A386	10 y	IGY-Penguin-Satellite	Japan
1957	370A113	10 pf	Sputnik I-IGY	E. Germany
1957	41A20	4.00	Pencil Rocket	Ryukya Is.
1957	1959A1034	40 k	IGY Rocket	USSR
1957	1991A1055	40 k	Ziolkowsky Anniv.	USSR
1957		40 k	Ziolkowsky and Sputnik overprint	USSR
1957	1992A1056	40 k	Sputnik I	USSR
1957	1993A1056	40 k	Sputnik I	USSR
1957	838A337	75 h	Sputnik II	Czech.
1957	C51AP23	3.75+25	Sputnik I & II	Romania
1957	C52AB23	3.75+25	Sputnik I & II	Romania
1957	1200A446	1.20 l	Laika-Sputnik II	Romania
1957	1201A446	1.20 l	Laika-Sputnik II	Romania
1958	2032A1072	20 k	Sputnik II	USSR
1958	2035A1072	1 r	Sputnik II	USSR
1958	2083A1099	40 k	Sputnik III	USSR
1958	2077A1094	60k	Rocket-Atom Disarmament	USSR
1958		10¢	Vanguard "Grapefruit"	Haiti
1958		50¢	Vanguard "Grapefruit"	Haiti

Astronautics Course Begins at AF Academy

COLORADO SPRINGS—Keeping in close step with the air-space age, the U.S. Air Force Academy has added a course in Astronautics to an already busy curriculum.

First Class cadets, members of the Academy's first graduating class of June, 1959, are now taking the course which covers the fundamental physics of manned and unmanned flight through space. The new Department of Astronautics got underway shortly after the Cadet Wing moved this fall from its temporary home at Lowry Air Force Base in Denver.

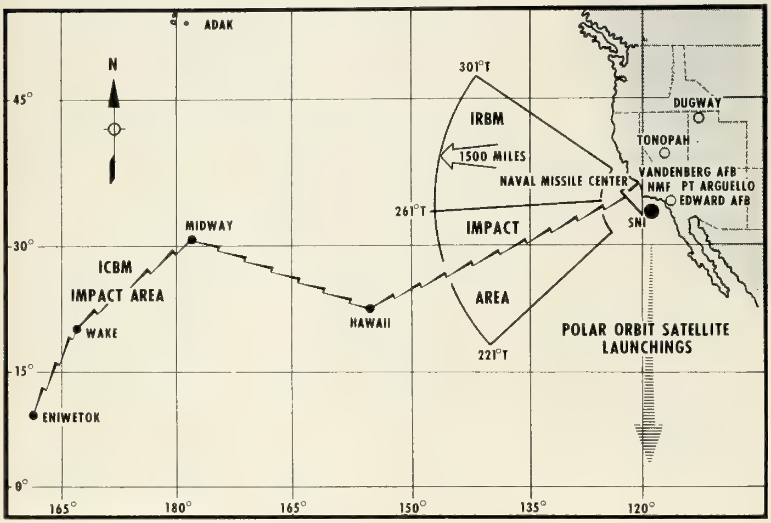
The department is headed by Colonel Benjamin P. Blasingame, who holds a Doctor of Science degree in Aeronautical Engineering from Massachusetts Institute of Technology and who, two years previous to his assignment to the academy, was director of the Air Force program to develop the *Titan* ICBM.

Colonel Blasingame served for more than three years with the Air Force Ballistic Missile Division at Inglewood, Calif.

Astronautics at the Academy includes ballistic missiles, satellites and space vehicles. The cadets study trajectory characteristics, rocket power plants, terminal trajectories, stabilization, control and guidance. The students make a survey of test techniques and weapons systems case studies on airborne and rocket vehicles.

U.S. Planning Manus for Equator Launch Site

Multi-billion dollar expansion of PMR facilities is proposed. First priority is extension of Sea Test Range for IRBM



PACIFIC MISSILE Range will encompass this area of island tracking sites.

POINT MUGU, CALIF.—Manus, largest island of the Admiralty group, and a forward base during World War II, may become the United States' equatorial launching site for space vehicles.

The island, under United Nations mandate through an Austrian trust, reportedly is under consideration in U.S. multi-billion dollar development plans for the Pacific Missile Range over the next 15 years. The Navy will operate the range.

PMR is seven ranges in one—each with specific functions. Ballistic Missile Range performs dual functions for IRBM and ICBM tests. The ICBM portion is an extension of the IRBM range centerline. Other ranges are Polar Orbit, Equatorial Orbit, Sea Test, Inland, Anti-Missile-Missile and Nuclear—six designations, but seven operational activities.

- **Here are plans**—First expansion will be of the Sea Test Range until it spreads 1,600 miles between Seattle and Baja, Calif. and a distance of 5,000 miles out to sea.

The IRBM range will extend 1,500 miles from Vandenberg AFB and Point Arguello, being centered on a medium bearing of 261 degrees. Maximum launch courses will be between 301 and 221 degrees True. Basic launch course for ICBM's probably will be 261 degrees True, with impact 75 miles NE of Wake Island.

ICBM's of greater range would travel across New Guinea, northern Australia and North Africa, with impact in the Atlantic.

The Anti-Missile-Missile and Nuclear Range pass through the general area of Midway, Wake, Bikini and Eniwetok, and should offer excellent possibilities for testing AMM systems against nuclear systems in inter-island intercepts.

Second on priorty for PMR is the Polar Orbit Range for the *Discoverer* program (m/r, Dec. 15, p. 18). Launch course will be close to 180 degrees True, and tracking will be by ship at the junction of the equator at 123 degrees West Longitude. Satellites probably will pass over the British-owned Ducie Island, where additional instrumentation may be located. A second range ship will be stationed south of Adak Island in the Aleutians.

- **Recovery zones**—Combined recovery zones for both the Polar and Equatorial Orbits extend from the equator north to 17 degrees North latitude on a line between 157 degrees West and 172 East longitude. Largest land masses in the area are Tarawa, Howland, Baker, Palmyra and the Marshall Islands.

Phase II of the *Discoverer* program, which involves use of the *Atlas* means a change of sites from Vandenberg to special facilities about four miles inland from Point Arguello. However, Air Force will perform the work.

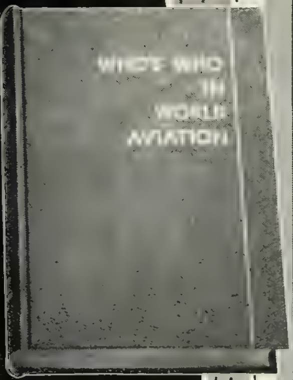
Some of the projects the Navy anticipates will be underway and assigned to PMR by 1961 are; *Nike-Zeus, Pershing, Polaris,* and *Minuteman.* While these plans are not firm, they are, however, under consideration in Washington.

Firm site selections have been made at the Navy facility. Included are *Terrier* and *Hawk* launch pads; range operations building, telemetry building, surveillance, radar tracking, radar, radio receiver building, UHF and HF-VHF transmitter building, and a public works building.

A limited amount of construction is now in progress. Sites have been proposed but not firmly selected for a central launch control in Spring Canyon; a 150,000 pound thrust launch complex, and a 1.5 to 3 million pound thrust launch complex in La Honda Canyon; and volume fuel storage facilities in Bear Creek Canyon.

Instrumentation facilities on Oahu, Midway and Wake Islands, reportedly is near completion. Plans are still being developed for Eniwetok, Bikini and Manus.

The Manus-Christmas Island complex, which could be tied in with Australia's Woomera Range, offers the possibility that it could be used for *Dyna-Soar* tracking in cooperation with other Pacific stations.



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m/r personal profile

Dr. James R. Killian: Science 'Mystery Man'

by Erica Cromley

As we prepare to penetrate outer space, we have the exciting opportunity to open a new window on the universe.
—James R. Killian, Jr.

WASHINGTON—Dr. James R. Killian, Jr., is one of the most influential men in Washington but one of the least known. In his double-hat role as Special Assistant to the President for Science and Technology and Chairman of the President's Science Advisory Committee, Killian counsels the Chief Executive in such vital areas as the nation's space and missile programs, atomic energy projects, and the exchange of scientific information with other countries. Involved are the nation's defense, its technological superiority, its economic growth. Yet to most Americans and even to some of Washington's "inner circle," Killian is a man of mystery.

It is no easy task to dodge the spotlight in the news capitol of the world, thoroughly probed by more than 1,000 press correspondents. Except for a quick publicity once-over when he was named to the White House post a year ago, newsmen have been unable to dig up much on the man himself, or to comprehensively analyze the extent of his power. His immediate staff is also in the dark about many of his activities, including his appointments with Eisenhower.

Reason given by his office for press-interview turndowns: "His heavy schedule won't permit it." Even invitations to appear before Congressional hearings, considered by many as "command performances," are refused because "this is inconsistent with his position as Presidential advisor." The Senate space committee, which wanted him as leadoff witness during hearings on the bill to set up the new space agency, had to settle for James Doolittle.

Although there is much that is secret about the job, there is strong feeling that much of the mystery could be unveiled in the public interest. Said one scientist, active on the Washington scene: "He may be doing great things but how would we know?" Aside from the security aspects of the science advisor's work, Killian is kept in the shadows, it is said, to insulate him from "non-political pressures"—industrial contacts who would want to push their pet projects.

- **Frequent visitor**—One index of his influence on the national scene is the frequency of his visits to the Presidential office. During one recent month, the White House appointment book lists 10 Killian visits with Eisenhower personally, and six sessions with the National Security Council and the President's Cabinet. One day that month he saw the President four times. In addition to the recorded appointments are impromptu informal consultations from time to time.

To keep the President up-to-date on top scientific developments and their significance, Killian has the help of about 100 experts—10 full time staffers, about 70 consultants and the 18 members of the Science Advisory Committee. The committee's work is broken down into 15 areas, each of which is tackled by a panel of from five to 15 experts, not necessarily members of the committee itself.

While some of the panel names have not been revealed for security reasons, seven identified by Killian's office are: education, scientific information, space and science technology, research, science and foreign relations, disarmament (nuclear test cessation), missiles. These committees meet whenever a particular problem arises in their area, and report their conclusions to Killian. If there is disagreement, Killian is called in to hear both sides. Usually he ties together a conclusion acceptable to the majority. If necessary, he will call in outside experts to help shake down a problem.

Although his reliance on the group brain-storming sessions would tend to belie the "Czar" tag given him by the press at the time of appointment, how closely he follows these group views when he has the President's ear is known only to Killian.

Keeping the commander-in-chief informed on scientific matters of grave import keeps Killian nimble-footed. A typical day looks like this: A.M.: staff conference, meeting with a panel chairman, session with Undersecretary of State Christian Herter, National Security Council meeting. P.M.: luncheon meeting with panel members, speech-writing session, ironing out a panel disagreement, confab with Ike, meeting with top foreign scientists. Hours covered: 8 A.M. to 7 P.M.

- **An appraisal**—Opinion on Killian runs from warmly in favor to mildly against with the pros ahead. The top strata of nation's scientific community on the whole seemed gratified when Eisenhower announced the appointment November 1957, a month after *Sputnik I.* The President said at the time: "Dr. Killian will see to it that those projects which experts judge have the highest potential shall advance with the utmost possible speed. He will make sure that our best talent and the full necessary resources are applied on certain high-priority top-secret items . . ."

Killian's year in office has seen creation of three new agencies dealing with space. The Defense Department's Advanced Research Projects Agency, the National Space Council and the civilian National Aeronautics and Space Administration. Among the non hush-hush achievements in which the science advisor played a key role was passage of the National Defense Education Act, expanded funds for research and development, reorganization of the Pentagon and publication of the "space primer," *Introduction to Outer Space,* which was read country-wide after a printing that ran into the millions.

One political hot potato that cooked in the Killian office was whether or not to transfer the Army Ballistic Missile Agency's team of crack scientists to the civilian space agency. Although Killian did not publicly express his views on the issue, he undoubtedly gave advice to the President, possibly toward the benefit of NASA. Because he has been quoted as saying: "The use of science for defense is necessary and we cannot be strong without it. But such use of science and technology is not a natural or satisfying use and in the end can only thwart and distort their true spirit."

Although details of the Killian operation are obscure, the government's top research and development people are well aware, sometimes painfully, of his "go, no-go" authority.

Said one high Navy R&D official: "To say that James Killian wields tremendous power is an understatement. If he approves a program, it's on its way.

"A lot of people don't like him because he won't approve their pet ideas," he added. "I like him and if I can't justify an idea to him, I'm satisfied there's a good reason. Biggest disadvantage about Killian is that while he has a lot of authority, he has no responsibility—he doesn't have to live with his sins. If this man were of Cabinet stature and had responsibility it would be better for the United States."

This criticism of the nature of Killian's role is echoed periodically in scientific and space-industry circles. Said one missile industry official recently; "If anybody has authority they should also have the responsibility. He tells ARPA and NASA what to do but if something goes wrong they get blamed."

Strong criticism of the job he is doing, however, is hard to come by. Biggest specific gripe is that he is not paying enough attention to the scientific manpower problem. One member of the panel concerned with that problem, complains that he has yet to call a meeting on the subject.

Killian supporters point out that his position is formidable—"an almost impossible one"—and that he is doing an extremely competent job under tremendously difficult conditions.

Although not strictly a scientist, Killian's standing in the world of scientists stems from several sources: his success as president of the Massachusetts Institute of Technology, the competence with which he has handled past government-scientific assignments, his quick grasp and analysis of technological problems, and his abilities as an administrator which includes keen judgment in evaluating the men he selects to help him.

Said a Capitol Hill space committee staffer: "Although Killian is not a figure in the space world, he is one in the science world. He may not be competent in any one field, but he does know who is. He can reach down in the scientific community and pull out just the man he needs. He is an excellent people-dealer."

He is described by those closest to him as determined, strong-willed, reasonably selfless, perceptive, somewhat complex, serious, reticent about pushing himself, dispassionate but warm.

His immediate staff says he is easy to work with and shows concern about the well-being of those who work for him.

The Killian office is a rather austere green-painted, high-ceilinged room approximately 22 x 18 feet with a picture of Eisenhower hanging on the wall behind his desk, and a view of the White House, directly across the street from the Executive Office Building. Except for the fireplace, it resembles the staid Congressional offices in the old Senate and House Office buildings.

It is here that he writes most of his speeches. Killian, who will have nothing to do with ghost writers or staff-written speeches, gained his fluency with words when he was editor of MIT's technical review.

Killian's approach to his job and his basic philosophy is perhaps best revealed through his speeches. The following are excerpts:

- **On research**—"We need to stabilize the support of research by both public and private agencies. Starts and stops, ad hoc commitments, and modification of research programs have at times kept the national effort off balance and have occasionally served to dissipate our efforts rather than to augment them . . .

In stressing the "importance of maintaining and increasing research and development in a time of recession," Killian declared: "Advancing technological knowledge provides a company with the agility to react rapidly to changing economic conditions . . . It helps in planning future goals by the systematic, planned discovery of new products and methods of making them. This is true no less for the nation as a whole, than it is for an individual firm."

". . . more than ten billion dollars are being spent annually by industry, government, universities and other non-profit institutions on research and development . . . By far the major total of the ten billion dollars is expended for development, and over the past decade there has not been a comparable increase in basic research [*which*] drives to the heart of the qualitative problem we face."

- **On his job**—"The [*Science Advisory*] Committee serves as a board of directors or consultants to me as Special Assistant to the President . . . We have no operational responsibility . . . My function and that of the committee is to provide answers to questions raised by the President . . . to mobilize the best scientific advice of the country and to make recommendations to him in regard to ways by which United States science and technology can be advanced.

- **On education**—"We should not engage in an academic numbers race with the Soviets. We must not throw quality out the window in order to handle numbers . . . Our colleges and universities should raise their entrance requirements in order to set a higher standard for the secondary schools . . . particularly should admission requirements be increased in English and mathematics . . . There is the need for earlier identification and cultivation of high talent, as early as the seventh or eighth grades . . . [The four-year undergraduate engineering program] must be supplemented by expanded graduate study in engineering. Many industries have been ahead of the colleges in recognizing this need . . . it would be more appropriate and advantageous in the long run for them to receive their advanced training in the university, rather than in industry . . .

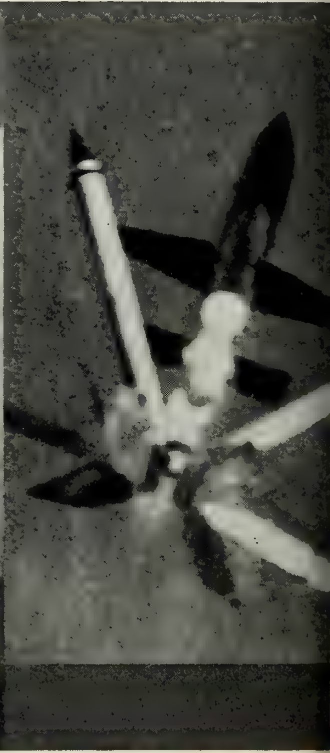
- **On the space race**—"We contiinue to be outstandingly strong in nuclear physics, in solid-state physics, in polymer chemistry and in high-speed calculating machines. In high-energy nuclear physics the Soviets are developing fast and may indeed grow to excel. But in low-energy nuclear physics, which is directly related to applications, the outstanding position of the United States is beyond dispute . . .

"The problem before us is not our leadership in technological strength today; the challenge we face is maintenance of this position tomorrow.

FOR BRITA

Missiles and launchers readily transported on light limbers; rapid installation on site

Launching, assisted by rockets; main ramjets burn safe-to-handle kerosene



Rockets jettisoned; ramjets, started
from cold, already giving even more spe

Approaching full operational status with the RAF as mai
stay of Britain's air defence...

Proved in many hundreds of test firings...

Adopted by Sweden after exaustive consideration of surfac
to-air guided missile systems available throughout the world

Bristol/Ferranti Bloodhound forms the world's most effecti
defence system now and for many years to come.

WEAPON DESIGN AND CONSTRUCTION BY BRIST

N'S DEFENCE

e homes on to target; semi-active guid-
system ensuring highest accuracy

Missile closes in; moving wing control holds course, whatever evasive action target takes

Missile gets within lethal distance; proximity fuse detonates warhead—target destroyed

urity forbids publication of full details, but the follow-
facts about Bloodhound can now be given:—

ver. The Bloodhound is powered by two Bristol ram-
—jet engines with no moving parts. Ramjets ensure
ver and range flexibility, burn kerosene, are simple and
to handle.

ming System. Semi-active: i.e., ground crew directs
ar beam on to target, which is reflected to a receiver in
odhound, ensures highest accuracy—regardless of
ge. Missiles may be fired, singly or in salvoes, using only
radar.

rame. Employs unique and advanced monoplane
ving wing configuration—two advantages:– quicker
and more precise response, as well as greater accuracy of interception; superior at high altitudes. This configuration was selected at initial design stage to embody maximum development potential.

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Bloodhound

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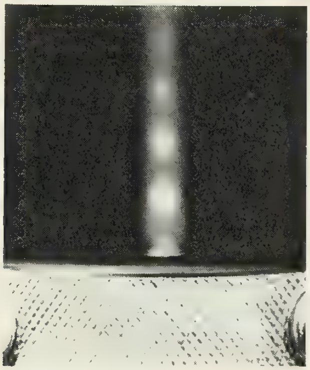


PLASMA TORCH mounted in wind tunnel for missile research.

New Plasma Tools Handle Ultra-Hard Metals

by Peer Fossen

WASHINGTON—The word "plasma" when mentioned in conversations these days, immediately makes one think of space science, and the power that will be used for space travel.

This is only natural, since the publicity given to plasma in the past few months has been focused on the space side of the art as a result of several significant breakthroughs in the field. Programs for plasma in space are being carried out by such organizations as Plasmadyne Corp. (m/r September 29, p. 11), General Electric (m/r October 6, p. 29), Avco Research Republic Aircraft, Vitro Corporation, and Lewis Flight Propulsion Laboratory of NASA. (The basic principles for generating plasma were described in m/r, September 29.)

It is, however, significant to note that while plasma as a power source in space still has to be proven, plasma devices can be used on earth to fabricate metal components for such things as rocket nozzles and nose cones for re-entry purposes.

• **Latest tools**—The latest additions to the line of plasma tools were recently introduced by the Linde Company, a division of Union Carbide Corporation. Considered by the Linde Company as involving a radically new method, the devices are capable of fabricating metal shapes and applying coatings that will withstand temperatures above 5000 degrees Fahrenheit.

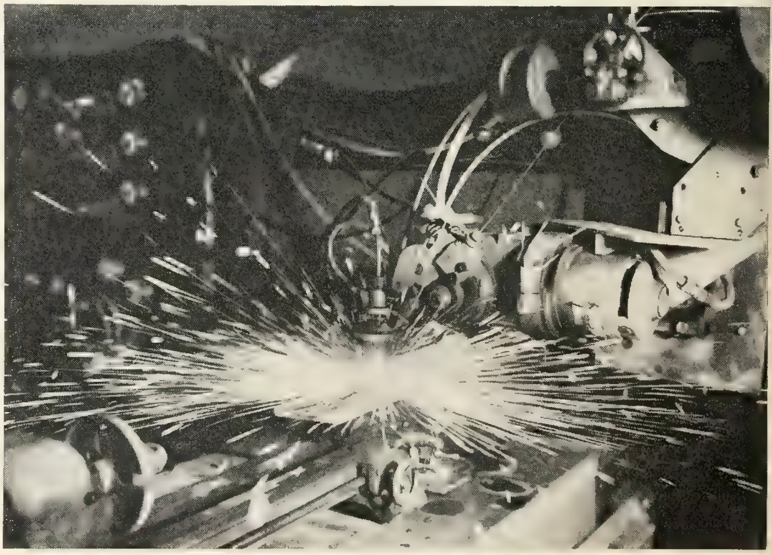
The process, harnessing controlled temperatures up to 30,000 degrees F, makes possible mass production of ultra-hard materials which have been considered practically unworkable by conventional metal-working methods.

In Linde's plasma torches, as these devices are called, the metal or substance to be worked is prepared in either wire or powder form and is then passed through an intense arc that is struck inside the torch. At this point temperatures above 15,000 degrees are reached.

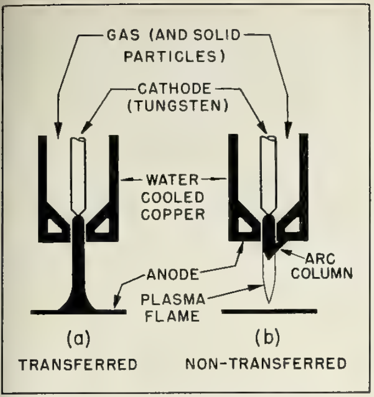
• **Material is converted**—Because of the high heat of the plasma arc, the material passing through is converted into a fluid or plastic state. It is then carried out of the torch by inert gases flowing at high velocity and is finally deposited on the part being made or plated with such force that a firm bond results.

The choice of wire or powder—and there is a separate torch for each—is largely one of convenience or economics. Stainless steel, for instance, is readily available in wire form and would most often be wire-fed.

Tungsten and the carbide materials, on the other hand, are more usually found in powder form and are regularly used in this form.

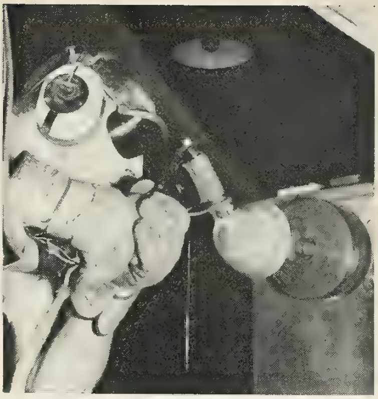


WIRE FED plasma torch coats stainless steel on aluminum plate. Fed from a spool, the wire is preheated before entering the torch's arc chamber.



BASIC TYPES of plasma torches. Transferred arc is used for metal cutting, non-transferred for metal coating.

THESE PARTS have been produced with Linde's torch, making possible handling of critical metals.



TUNGSTEN IS applied to missile nose cone with torch, after being drawn into the arc in powder form.

In a plasma torch, most inorganic materials that melt without decomposing can be used. Some of these materials are:

1) The refractory metals such as tungsten, tantalum, columbium, molybdenum, niobium and rhenium.

2) Some of the refractory metal compounds such as borides of zirconium, tungsten, niobium, tantalum, titanium, chromium.

3) The refractory carbides of niobium, hafnium, tantalum, zirconium, titanium, tungsten, vanadium.

4) The refractory oxides of thorium, hafnium, magnesium, zirconium, cerium, aluminum.

5) The noble metals—platinum, palladium and others in that group plus their alloys.

Of particular interest is the use of the plasma torch for formed metal shapes, such as a tungsten part. This is accomplished by depositing a coating to the required thickness over a precisely made brass mandrel.

At this stage the tungsten has a density of 94 to 95%, a modulus of rupture of 44,000 psi and a Young's modulus of 22 x 10^6 psi. The mandrel is removed in acid bath which attacks the brass only. The shape is then fired in an inert atmosphere furnace for two hours at 1400 degrees C.

After firing, the density is increased to 97-98%, the modulus of rupture to 57,000 psi, and Young's modulus to 34 x 10^6 psi. The volumetric and linear shrinkage upon firing are 2.2% and 0.7% respectively.

• **Other uses**—In addition to experimental rocket and missile parts of pure tungsten or tungsten-coated graphite, the metal forming method has been used to produce high density tungsten crucibles for metallurgical purposes, special parts for nuclear work, sensitive electrical contacts, and electronic components and x-ray targets of superior density.

Coatings made with the plasma method, using the powder type torch, will bond good to most any base material including some re-inforced plastics, graphites, and carbons. These bonds are generally chemical and mechanical in character and exceed those obtained by electroplating, vapor deposit, or metal spray.

The coatings are very dense, usually laminar in structure and may be finished to below 10 microinches.

The areas of application of plasma torch coatings are manifold and cover practically every industry.

Typical work is the application of plasma coatings in the production of refractory parts—such as crucibles for melting high melting point materials, for example, silica. Several distinct advantages are claimed in forming these parts with the plasma torch.

They can be made structurally sound without resorting to heavy walls. They are dense and can be made with high surface finishes. The thinnest practical crucible wall understood to be made by other processes is 0.125″, more commonly, however, this thickness ranges in 0.250″ area.

Plasma arc formed crucible wall thickness are generally .040″ to .060″. Consequently they should, under full production pricing conditions, be more economical.

• **Permanent molds**—Another refractory application is special permanent molds for high temperature service. These may be coated with suitable refractory materials. An example of this is a section of a molybdenum base metal mold coated with tungsten, that can be used to cast a highly radioactive metal rod. Other parts used to process radioactive materials have been coated with both tungsten and tantalum and are under test, according to the Linde Co.

The company does not plan to market any of the patented plasma torch devices at this time, but is prepared to accept orders for parts coating or parts fabrication, either in production or in experimental quantities.

• **Other companies**—Leading companies in the production of plasma jets or plasma torches, in addition to Linde, are Plasmadyne Corporation, a division of G. M. Giannini & Co., Inc., and Thermal Dynamics Corp.

Plasmadyne has for some time been developing tools for coating large metal surfaces, including the inner surfaces of liquid fuel tanks for rockets. This company has also been developing tools for fabrication of redomes and domes for infrared devices. Plasmadyne torches, which have been offered for sale for more than a year, are substantially different from other torches on the market, according to a company spokesman.

Thermal Dynamics has equipment for sale which has been designed particularly for research and development purposes. Straight commercial use is controlled through licensing. The company has three standard torch sizes available—24, 50, and 100 DC KW, with various special attachments for modification. One modification of the torch design permits generation of temperatures over 60,000 degrees Fahrenheit at heat transfer rates 5 to 10 times that of the standard torch.

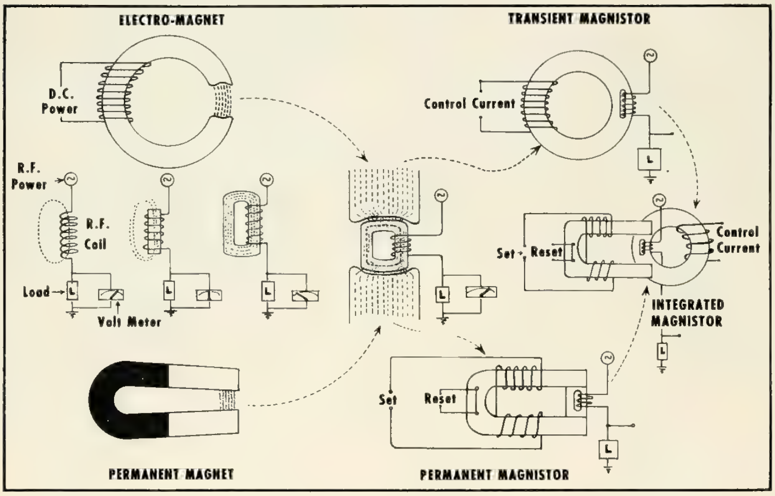
Thus, the problem still stands: Plasma as power in space still must be proven. But there are multiple uses—especially in metals today. Research is paying dividends, as the Linde Company has found out.

Computer Component Has Reliable Inert Materials

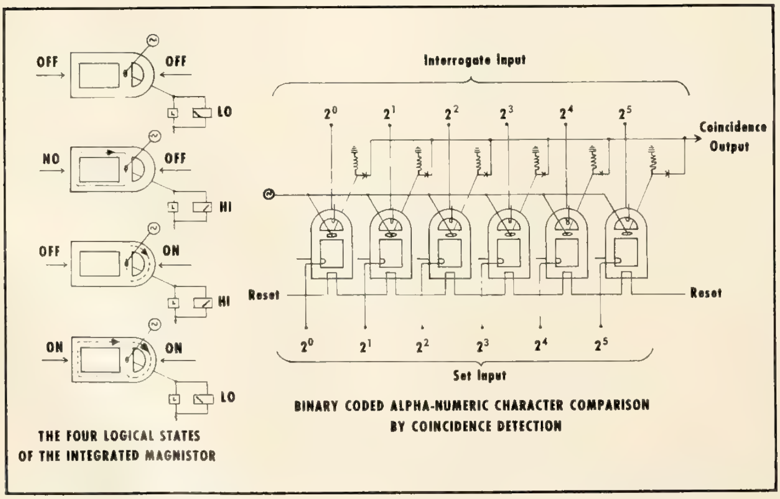
Transient permanent magnistor can be placed into data processing circuits

by Raymond M. Nolan

NEW YORK—A new computer component—called a transient permanent magnistor—is so rugged and reliable that it can be incorporated directly into data processing computer equipment circuits without replacement according to the manufacturer, the Potter Instrument Company located in Plainview, New York.



EVOLUTION of the integrated magnistor from standard magnetic sources.



FOUR POSSIBLE magnetic states within the MPT-1 transient permanent magnistor, left. Six-bit combination for coincidence comparison, right.

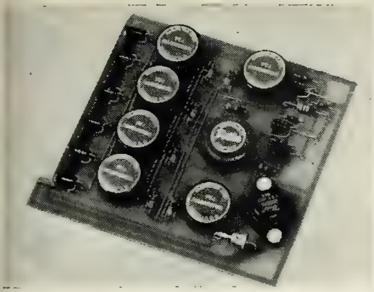
Sealed in epoxy plastic, the dime-size component will also make possible high speed printer systems two-thirds smaller than those now in use by the Armed Forces in space experiments.

The Potter MPT-1 magnistor is a solid state magnetic component composed of inert materials in an apparently reliable and versatile arrangement. High retentive ferrite combined with a high permeability low retentive ferrite is employed in the configuration to achieve characteristics not now attainable in one component, the Potter Company said.

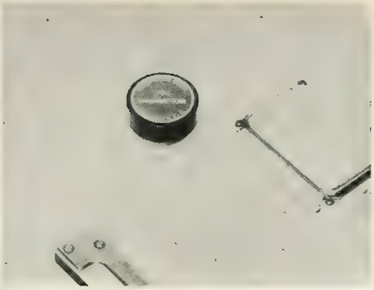
The MPT-1 is an eight-terminal device. SET input terminals provide access to the high retentive ferrite for data storage in the same manner as with conventional ferrite cores. The RESET winding, when actuated, dissipates the stored magnetism. The resulting alternate states of magnetism are indicated by a two-state change of inductance of an RF signal winding.

The INT (interrogate) winding is associated with the high permeability ferrite and effects an identical change of the RF signal winding inductance. However, with the lack of magnetic retentivity, the response is proportional to the applications of current to the INT winding. When both magnetic circuits are considered in combination, the effects of each with respect to the other is of a complementary nature. This result reveals an identity to the half adder (less carry) that is used in digital computers.

• **Magnetic states**—The four possible magnetic states within the MPT-1 and the corresponding relative values of the signal winding inductance are shown in the accompanying illustration. For the upper left figure, with no magnetic flux from either the permanent or transient sections, the signal winding will show a high inductive value. With saturating flux from either of these two sections, as in the second and third figures, the signal winding inductance will be



COMBINATION of six MPT-1 transient permanent magnistors and Q-1Y 10 Mcs signal source.



RELATIVE SIZE of the Potter magnistor. Unit is so rugged that no replacements are necessary.

considerably reduced. With both sections energized as in lower figure, the saturating flux through the signal winding core is removed by the proper polarization and coercive effect of the energized interrogate winding. A six bit combination to satisfy the requirements of a coincidence comparison is shown on the right side of the diagram.

For equal input states, that is "off-off" and "on-on," a high inductance will be displayed, whereas for unequal inputs such as "on-off" and "off-on" a low inductance will result. This takes the form of a differentiating detector between equal and unequal states combined with storage for one state. Possible digital applications for this are: sorting and collation, coincidence detection, parity checking and digital servo follow-up.

An RF signal source is part of magnistor technology and Potter uses a Q-1Y 10 mcs source. This unit is a complete oscillator package, fully encapsulated, and designed for printed circuit applications. A minus 20-volt DC input will produce an output signal of approximately 2-volts RMS of sufficient power to accommodate more than 10 magnistors. The size of the Q-1Y makes is possible to group several magnistors for a specific logical function as shown in the photograph.

The magnistors are to be produced in Puerto Rico. John T. Potter, company president, said a key reason for producing the new type units in Puerto Rico was the high manual dexterity and productivity of Puerto Ricans in delicate coil-winding and assembly done under magnifying lenses. He also said that the parent plant in Plainview has already received the first shipment of magnistors from its island affiliate, Magnistor Corporation, Luquillo. In connection with this, Hector E. Pineiro, U.S. Industrial Promotion Director for Puerto Rico's Economic Development Administration, noted that Magnistor Corporation is among 50 electronics affiliates established in Puerto Rico since 1950 under the "Operation Bootstrap" industrialization program.

Potter noted that "three years of testing by our engineers have shown the magnistor to be extremely reliable. The magnistor stores energy indefinitely. It avoids in part electronic connections which are subject to loosening and deterioration. Sealed in epoxy resin, the magnistor can withstand operating temperatures beyond 220 degrees F."

Tentative specifications for the MPT-1 magnistor and the Q-1Y 10 mcs source are:

MPT-1 MAGNISTOR at 100 DEGREES C

	Resistance (ohms)	Inductance	Current (±20 %)
SET	5	*95 uh at 1 mc	100 ma
RESET	3	*35 uh at 1 mc	120 ma
INTER-ROGATE	6½	700 uh at 1 mc	120 ma
RF SIGNAL	1	Set: 18 uh at 10 mc Reset: 90 uh at 10 mc	

Typical RF signal voltage: 2-volts RMS

* This value is for initial and final inductance; during the transition period the inductance may rise by a factor of ten. Height from case top to bottom of pins: .75-inch Diameter: 1-inch (overall).

Q-1Y 10 MCS SOURCE

Input voltage	minus 20-volts DC (max.)
Input current	10 milliamps
Output voltage (loaded)	2 volts RMS
Frequency	10 mcs plus or minus 5%
Temperature	55 degrees C (max.)
Height (to base of pins)	9/16-inch
Diameter (overall)	13/32-inch

BMEWS Are Reported Solidly on Schedule

WASHINGTON—In a joint progress report made public by Brig. Gen. Charles B. Root, chief of the USAF Electronic Defense Systems Division, and William L. Richardson, Administrator of the BMEWS project for RCA, it has been announced that construction of BMEWS (Ballistic Missile Early Warning System) is solidly on schedule as winter sets in and brings the long night to the arctic.

One base where several hundred workers are leveling ground, building roads and constructing facilities was cited in the report as an example.

One part of the program in the summer—when temperatures were steadily above freezing—was erection of rubber shells about the size of circus tents. In the warmer months, the shells were moved from place to place as concrete footings and foundations were finished. This will allow outside superstructure work to proceed through the winter.

Port facilities are normally free of ice for three summer months of the year. But this year, the Military Sea Transportation Service devised a method of keeping them open another month. Three 1,000-foot long tubes were lowered into the water at the sides of the docks, with compressors attached at the top. The compressors pumped air down to the tubes, sending air bubbles constantly up from the bottom to keep the water churning and prevent the formation of ice. The exercise was dubbed "Operation Polynya," using an arctic word that describes a phenomenon of the region—a pool of open water that forms seasonally in areas otherwise completely frozen over.

BMEWS is managed by Air Materiel Command with the assistance of Air Research and Development Command and the Air Defense Command. RCA is the prime contractor with offices at its Missile and Surface Radar Department at Moorestown, N. J.

Bell System Used for *Regulus II* Tests

BUFFALO, N.Y.—An automatic all-weather landing system, developed for use aboard Navy aircraft carriers, has landed the *Regulus II* surface-to-surface guided missile twice as part of an evaluation program.

The landings were made at Edwards Air Force Base, Calif., on October 8 and October 15, Bell Aircraft manufacturer of the landing system, disclosed.

Purpose of the test program was to determine whether the automatic system could be used to recover the *Regulus* missile after test flights at the California base.

The Bell system which uses a combination of radio and radar, locked on the missile's autopilot several miles from a selected point of touchdown and guided it to a safe landing.

Another type of automatic control system has been credited with saving more than $100 million during the *Regulus I* program by landing missiles more than 600 times after evaluation flights.

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Synthetic Crystals Produced

CINCINNATI—Details of pilot plant production of synthetic quartz crystals were given in a paper presented at the American Institute of Chemical Engineers meeting here. The paper described the production facilities that are now growing large crystals by the hydrothermal process in limited quantities at Western Electric's Merrimack Valley Works in North Andover, Mass.

In addition to its availability in any quantity and size, synthetic quartz provides other advantages. Seeds can be cut to provide grown crystals which can be sawed efficiently. The material also has natural faces which allow easier orientation of the stock for cutting into units. It contains none of the foreign inclusions which usually occur in natural quartz, and it can be produced without either optical or electrical twinning.

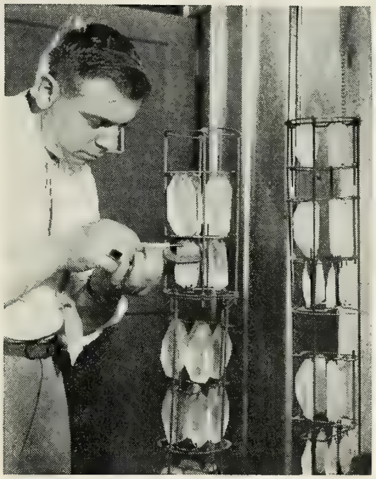
In the pilot plant, quartz crystals up to two to three inches in each cross section and five to six inches long have been grown by the hydrothermal process.

- **Autoclave used**—In the hydrothermal process, a long, narrow autoclave mounted vertically is filled with an alkaline solution, usually solium hydroxide. Small pieces of natural quartz are placed in the bottom of the container to provide the nutrient. Western Electric plans to use high quality sand as the future nutrient.

Seed plates cut from either natural or previously-grown synthetic crystals are hung from a rack in the upper section of the autoclave. After sealing, the vessel is heated and maintained under a constant temperature differential from bottom to top for the desired time, which varies from one to several weeks depending on the experiment.

Economical growth rate in excess of 60 thousandths of an inch per day has been achieved. Since growth occurs primarily in one dimension, flat seed plates are used which effectively become thicker but change little in other dimensions. The rate of growth varies with temperature differential, alkilinity, temperature and pressure of the vessel.

Operation of the hydrothermal process depends on the maintenance of a temperature differential between the nutrient area and the seed plate area. The nutrient dissolves in the hotter lower region and is carried by convection currents to the cooler upper region. The lower temperature here leads to a supersaturated condition in the nutrient solution, which causes the dissolved quartz to redeposit into the seed plates in single crystal form.



QUARTZ CRYSTALS are measured.

Main problem that faced Western Electric was closure for the autoclaves. Laboratory units were welded tubes supported by capped, high pressure piping. A repetitive closure was required for the larger autoclaves and a satisfactory closure was developed which gives a tighter seal as the pressure inside builds up.

Martin's IBDL System Now Operating In N.Y.

ORLANDO—A new system, called the Interim Battery Data Link (IBDL), manufactured by Martin's Orlando Division is being used for electronic coordination of Army air defense installations in the New York City area. The IBDL was accepted by the Army September 26 and became operational in October.

IBDL is installed at each *Nike* battery in the New York air defense system. The system is used as an interim measure which permits electronic coordination of missile batteries, and functions as a target data link between firing batteries of an air defense installation. Developed in conjunction with the Signal Corps, IBDL indicates to battery commanders, on their scopes, which targets are engaged by other batteries in the area. Possible targets, picked up by radar, appear on the screen of a scope. Each battery commander in the system sees the same information to assure that all targets will be engaged.

IBDL is intended as an interim system to be replaced by the Martin *Missile Master* system when accessory buildings and other preparations are complete. The only operating *Missile Master* system is at Fort Meade and works with the Washington-Baltimore air defense system.

Plans are to install the IBDL in every air defense area where *Missile Master* is to be installed and then to integrate IBDL into the *Missile Master* when it becomes operational.

Transistor Sales Hit Another Record High

WASHINGTON—Factory sales of transistors in October established another new high with a 10% increase over September, according to the Electronics Industries Association. Unit sales during the first 10 months of 1958 exceeded total sales for 1957. Sales in October were 36% greater than in October, 1957.

Transistor sales in October totaled 5,594,856 with a dollar value of $13,461,857, compared with 5,076,443 transistors valued at $10,811,412 sold in September and 3,544,000 units valued at $7,075,000 sold in October a year ago.

Cumulative sales of transistors during the first 10 months of this year, January-October, totaled 36,072,133 transistors valued at $83,692,052 compared with 21,396,300 valued at $56,131,000 sold during the corresponding 10-month period last year, EIA said.

Factory sales of transistors during calendar year 1957 totaled 28,738,000 units with a dollar value of $69,739,000, according to EIA's compilation.

Soviet Scientist Gives Peace Symbol to Johnson

SAN ANTONIO—Senate Space Committee Chairman Lyndon B. Johnson, one of the key men in the nation's space race with the Russians, has received a symbol of peace from a top USSR scientist.

Johnson, Senate Majority Leader, was presented a leaf of the ancient Ginkgo tree, from Prof. Gabriel A. Tikhov, founder of Russia's Institute of Astrobiology and renowned for his studies of possible plant life on Mars.

The Ginkgo, one of a species surviving from a remote geological era, grows in the institute's botanical garden at Alma Ata, Soviet Asia.

. . . New Warships

(Continued from page 7)

system, was developed in cooperation with Latecoere. This type has a longer range than the *Masurca*. Solid propellant rocket engines are used.

• **Ship-to-ship missile**—Finally, the French Navy has developed a ship-to-ship missile, the *Malaface* from which a ship-to-submarine version, the *Malafon* has been developed and will be installed on the escorter "T56—La Galissoniere" presently being built. The *Malafon* uses acoustic guidance underwater.

After having been successfully tried, at either the Ile du Levant naval test range or at the Defense Department test range of Colomb-Bechar, in the Sahara, these miscellaneous missiles will soon see their first sea trials next month, when the "Ile d'Oléron" test ship will take to sea. This ship is a former German transport which has been revamped by the Arsenal of Toulon.

The "Ile d'Oléron" will carry ship-to-air missiles, ship-to-ship missiles, a platform for a two-ton helicopter, an electronic center (which will be the most sophisticated ever built in a French ship), a platform for an eight-ton helicopter and two launching ramps for target missiles.

Besides having to meet special requirements like those of the U.S. Navy (as compared with those facing the Army or the Air Force), the French Navy also has to take into account the fact that its missiles have to be developed to operate from ships as small as 1,800/2,500-ton escort vessels.

In the future, however, the plans are to reconvert anti-aircraft cruisers like the recent "de Grasse" and "Colbert" with missiles replacing artillery and, from 1960 forward, to build a new generation of warships, especially designed for missiles and which will be in the 2,500/5,000 ton category.

The work completed already pays returns—one-third of the activity at the Ile du Levant test range is undertaken by operators other than the French Navy. The British and Swedish Navies have availed themselves of the facilities existing on the now well-organized Riviera test-range.

Are Changes Needed in IAF?

by Andrew G. Haley

President, International Astronautical Federation

Washington—Are the rocket and astronautics societies of the world, because of their membership in the International Astronautical Federation, losing the opportunity for preeminence in the communities of the natural and social sciences?

Based upon the events at the ICSU (International Conference of Scientific Unions) general assembly in October; United Nations proceedings in November; and actions taken at UNESCO (United Nations Educational, Scientific and Cultural Organizations) this month, there are several affirmative and highly favorable answers to this question. This despite the fact that the organizational complex of the IAF itself furnishes some negative replies.

The favorable developments are:

1) The unanimous adoption by the general assembly of ICSU in October, of the committee report of Professor K. F. Ogorodnikov (Academy of Sciences of the USSR, Moscow), Professor John T. Wilson (President of the Geodesy and Geophysics Union, University of Toronto, Canada), and Dr. Alan Shapley (U.S. Bureau of Standards). In this report, ICSU expressed its awareness of the useful activities of the IAF in furthering the science and technology of astronautics, and said it looks to the future possibility of arranging a more formal affiliation in matters of common concern.

2) The encouraging response from the Permanent Missions and the Secretariat of the United Nations when the services of three committees were offered on a consulting basis. The committees are: the UN Ad Hoc Committee on the Peaceful Use of Outer Space, the IAF Permanent Legal Committee, and the newly-constituted IAF Committee on International Cooperation.

3) The action of the general assembly of UNESCO in voting unanimously to give to the IAF full consultative status, and the action of the program committee of UNESCO in approving the recommendation of the UNESCO Natural Sciences Working Party that "exploration of extra-terrestrial space be added to the fields of research on which the Director General may be active."

• **Scientific help**—To say the least, these affirmative achievements were the results of never-relenting vigilance and of the unstinting help of many great scientists—Ogorodnikov, Wilson, Shapley, von Karman, Berkner, Malina, Singer and Kaplan, to mention only a few.

The negative factors, such as failure to change the constitution of the IAF to make the IAF eligible for membership in ICSU, flow directly from the conservative attitude of certain very strong IAF member societies which ordinarily would be fully justified in their attitudes. But they are not now because of dynamic changes resulting in the creation of such bodies as COSPAR (Committee on Space Research).

If the IAF had long since amended its constitution to provide for three divisions, namely, the Division for Space Sciences, the Division for Space Technology, and the Division of Social Sciences Related to Space Problems, the IAF would not only have accomplished the perpetuation of its existence as a great world nongovernmental organization in all fields of astronautics, but it also would have available for affiliation with ICSU a Science Division concerned with the broad spectrum of physical, mathematical, astrophysical and like sciences related to the study of space.

If such a division had been in existence, ICSU at the October meeting would have proffered affiliation to the IAF Science Division. Because the IAF as presently constituted cannot qualify as an astronautic science union under the statutes of ICSU, the latter had no alternative but to set up a special committee within its own organization.

• **COSPAR committee**—This committee is COSPAR and its existence is discouraging in a sense to the IAF. But under the circumstances, the creation of the committee was essential.

• **Changes needed**—ICSU has already demonstrated unprecedented recognition and friendship for the IAF. The IAF needs only to make the appropriate changes in its statutes to conform with the requirements of ICSU, and to provide qualified and recognized scientists from among the ranks of its member societies to become the ICSU affiliate.

A special meeting of the officers of the IAF and of the representatives of all of the member societies will be held in Geneva, or any other centrally located city, in May to agree upon positive statutory and other necessary changes. An obvious defect in the IAF Constitution is apparent because such interim meetings have no statutory sanction.

At this meeting perhaps majority decisions may be made which can be presented immediately on the convening of the London Congress for ratification on the basis of prior agreement.

when and where

DECEMBER

American Astronautical Society, Fifth Annual Meeting, Hotel Statler, Washington. Meeting will be held in conjunction with the 125th Annual Meeting of the American Association for the Advancement of Science, Dec. 27-30.

JANUARY

Fifth National Symposium on Reliability and Quality Control in Electronics, Bellevue-Stratford Hotel, Philadelphia, Jan. 12-14.

Southwest Electronic Exhibit, Arizona State Fairgrounds, Phoenix, Jan. 21-23.

Fifth Annual Radar Symposium (classified), Rackham Bldg., University of Michigan, Ann Arbor, Jan. 27-29.

Society of Plastics Engineers, 15th Annual Technical Conference, Hotel Commodore, New York, Jan. 27-30.

Armour Research Foundation, Fifth Annual Midwest Welding Conference, Illinois Institute of Technology, Chicago, Jan. 28-29.

FEBRUARY

14th Annual Technical and Management Conference, Reinforced Plastics Division, Society of the Plastics Industry, Inc., Edgewater Beach Hotel, Chicago, Feb. 3-5.

IRE, AIEE 1959 Solid State Circuits Conference, University of Pennsylvania, Philadelphia, Feb. 12-13.

1959 Engineering Exposition, Balboa Park, San Diego, Feb. 26-March 1.

MARCH

IRE, AIEE and Association for Computing Machinery, 1959 Western Joint Computer Conference, Fairmont Hotel, San Francisco, March 3-5.

Institute of the Aeronautical Sciences, Flight Propulsion Meeting (classified), Hotel Carter, Cleveland, March 5-6.

Western Space Age Conference and Exhibit. For information: Domestic Trade Dept., Los Angeles Chamber of Commerce, 404 South Bixel St., Los Angeles, March 5-7.

Gas Turbine Division of the American Society of Mechanical Engineers, turbine in action, Cincinnati, March 8-11.

American Society for Metals, 11th Western Metal Exposition and Congress, Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles, March 16-20.

propulsion engineering

by Alfred J. Zaehringer

Electric ramjet? Novel Soviet claim is the generation of ball lightning within a ramjet engine as a heat source. Distance and intensity of the discharge would be varied according to air flow. According to reports, this engine has been tested on the ground but development of high-power, light-weight power source may delay flight tests.

Ion rocket engine test lab is operational at Rocketdyne's propulsion field lab. The 40x40 foot lab can handle electric power rated at two amps and 40,000 volts. An ion engine—developing ounces of thrust—necessary to propel a vehicle to Mars might be small (nine inches in diameter and about two feet long) but it would use about 2,200 pounds of cesium propellant. Current price of this easily ionized, heavy metal is about $750 per pound.

U-235 fuel for an atomic rocket is expensive. AEC figures about $8,000 per pound for the highly enriched material. At the present state of the art, some 1,000 pounds of U-235 (in a gaseous thermal reactor) would only give an impulse of 1/10th that of the *V-2*. A separation factor of 100-1,000 better than current methods is required to retain unfissioned fuel in the core.

Ignition of metals in fluorine has been studied at Fenn College. Tests indicated that there is an ignition delay-temperature relationship for the fluorine-metal reaction. Nickel has a high ignition temperature while tungsten and molybdenum had the lowest among the metals run. The results point to the use of nickel and stainless steels as combustion chambers for fluorine propellants.

High temperature propellant systems have been evaluated by the Research Institute of Temple University. Hydrogen cyanide (HCN) when oxidized by oxygen and fluorine at 300 psi gives a c* of 6250 ft/sec and a flame temperature of 4,410°K. Cyanogen (NC:CN) burning with oxygen at the same pressure yields a c* of 6,100 ft/sec at 4,860°K. Tests were run in a rocket motor of two-inch exit diameter at the High Temperature Test Area, Elverson, Pa. Personnel wear gas masks using a self-contained oxygen source because of the toxic nature of the propellants.

Undue attention may have been lavished on combustion and flame research since the real physical situation in flames is so complex that a good theory may be unwieldy and cumbersome. This is apparently the feeling of Project Squid which has been monitoring US combustion research for years. Combustion researchers are not feeding enough vital data of concern to engine designers. As a result there is too much shuffling around.

Gaseous detonation with an eye to a propulsion device is being reviewed for the Air Force by the University of California and Fairchild Engine Division. Others are also studying the problem. A ramjet employing a standing detonation wave might be made to work at Mach 7. Fairchild is working on the release of chemical energy in supersonic flow in a new supersonic "combustion" tunnel.

Lithium perchlorate can be produced at the HEF (Hooker-Foote) plant at Columbus, Ga. Claim is that the plant is the only one capable of producing the new oxidizer. However, the present production of the plant will be for ammonium perchlorate—standard composite oxidizer. AP production capacity at this plant will be about four million pounds a year.

Advertiser's Index

Avco Mfg Corp. Agency Benton & Bowles, Inc.	35
Bristol Aircraft Limited Agency—Young & Rubicam, Ltd.	24, 25
Clifton Precision Products Co., Inc. Agency—Ivey Adv., Co.	36
Consolidated Electrodynamics Corp. Agency—Hixson & Jorgensen, Inc.	4
Diversey Engineering Co. Agency—Roark & Colby Adv., Inc.	6
Hydro-Aire, Inc. Agency—Gaynor & Ducas, Inc.	2
Janitrol Aircraft Div., Surface Combustion Corp. Agency—Odiorne Industrial Adv., Inc.	12
Scaife Co. Agency—E. A. Korchnoy, Ltd.	10
Solar Aircraft Co. Agency—The Phillips-Ramsey Co.	8
Titanium Metals Corp. of America Agency—W. L. Towne Adv.	3

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contract awards

ARMY

By U.S. Army Ordnance District, Pasadena, Calif.:

$112,217—**Gilfillan Bros. Inc.,** Los Angeles, Calif., for repair parts.

$94,899—**Townsend Engineered Products,** Santa Ana, Calif., for design & development.

$51,883—**Electro-Optical Systems, Inc.,** Pasadena, Calif., for investigation of gases.

$35,800—**Firestone Tire & Rubber Co.,** Los Angeles, for modification of guided missile equipment.

$32,966—**Douglas Aircraft Co. Inc.,** Santa Monica, for launching area items.

$66,631—**Douglas Aircraft Co. Inc.,** Santa Monica, for repair parts.

$48,960—**Northrop Aircraft, Inc.,** Hawthorne, for design studies.

$195,404—**Gilfillan Bros. Inc.,** Los Angeles, for repair parts.

$104,302—**Gilfillan Bros. Inc.,** Los Angeles, for engineering services.

$500,000—**California Institute of Technology,** Pasadena, for engineering research & development.

Army Ordnance Corps and Hercules Powder Co.:

$1.3 million—**National Electric Products Corp.** for production of metal part assemblies for use in the *Nike-Hercules* missile.

By U.S. Army Ordnance District, St. Louis, Mo.:

$25,284—**Benson Mfg. Co.,** Kansas City, Mo. for drum, aluminum shipping hydrogen peroxide 86 gallon 43 ID-492 and 495-59.

$37,786—**Heiland Div., Minneapolis Honeywell Regulator Co.,** Denver, Colo. for event recorder.

By District Engineer, U.S. Army Engineer District, Fort Worth, Texas:

$3,030,196—**Lawless and Alford, Inc.,** Austin, Texas for ICBM/IRBM training facilities, Sheppard Air Force Base, Wichita Falls, Texas.

By Purchasing and Contracting Division, White Sands Missile Range, N.M.:

$27,342—**Parabam, Inc.,** El Segundo, Calif., for reader, film cinetheodolite, angle dial.

By U.S. Army Signal Supply Agency, Philadelphia, Pa.:

$57,940—**Elgin National Watch Co.,** Burbank, Calif., for research and development work for 12 months leading to the establishment of miniaturized sensitive microminiature relays.

$39,720—**Hycon-Eastern, Inc.,** Cambridge, Mass. for research work for 12 months on overtone mode, thickness sheer filter crystals.

AIR FORCE

By Commander, Headquarters AMC, Wright-Patterson AFB, Ohio:

$55,287—**Westinghouse Electric Corp.,** Dayton, for power supplies for SM-62A missile.

$59,846—**Ladish Co.,** Cudahy, Wis., for systematic study to determine what factors caused fluctuation in the mechanical properties of large steel forgings.

$36,929—**Tube Division, Radio Corporation of America,** Harrison, N.J. for procurement of research and development of methods and techniques for manufacturing high sensitivity photomultiplier tubes.

$269,286—**Crucible Steel Co. of America,** Midland, Pa., for development of methods and machinery for cold rolling titanium and titanium alloy.

$120,205—**North American Aviation, Inc.,** Los Angeles, for structural analysis and flutter analysis reports.

$46,776—**Doehler-Parvis Division, National Lead Co.,** Toledo, for investigation of the effect of ultrahigh pressure exerted on castings during and prior to solidification.

$39,866—**Pioneer Parachute Company Inc.,** Manchester, Conn. for canopies and accessory hardware for experimental parachute systems for use with classified end items.

$51,335—**Systems Research Laboratories, Inc.,** Dayton, Ohio for development of high temperature, radiation resistant thermometers.

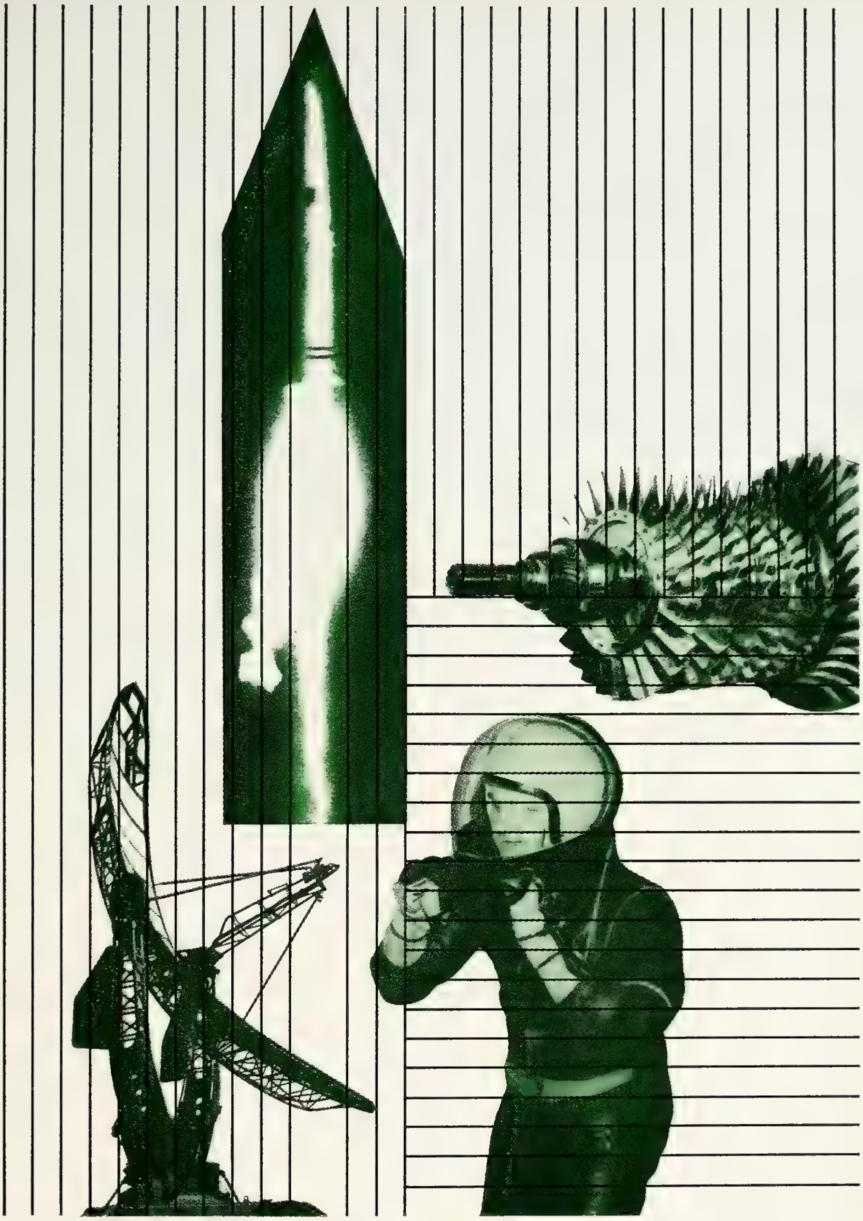
$86,439—**Dynamic Research, Inc.,** Los Angeles, for development, fabrication, and evaluation of a service test quantity of two recharging units, liquid nitrogen or oxygen, including supporting spare parts for three months operation.

$50,343—**International Electronics Engineering, Inc.,** Washington, for maintenance services for data reduction and specialized intelligence equipment.

$91,723—**Astrodyne Inc.,** McGregor, Texas for igniters for M15A1 jato units.

By San Antonio R&D Procurement Office, Wright Air Development Command, Lackland AFB, Texas:

$96,352—**Institute of Andean Biology,** Lima, Peru for research & reports on mechanisms of natural acclimatization.



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Torque Transmitter	CGC-8-A-7	26	.100	.54	11.8	206	8.5	37	12	54 + j260	12 + j45	80 + j20	30	7
Control Transformer	CTC-8-A-1	11.8	.087	.21	23.5	411	9	143	24	210 + j690	28 + j114	250 + j73	30	7
Control Transformer	CTC-8-A-4	11.8	.030	.073	22.5	393	8.5	365	64	470 + j1770	81 + j330	590 + j190	30	7
Torque Receiver	CRC-8-A-1	26	.100	.54	11.8	206	8.5	37	12	54 + j260	12 + j45	80 + j20	30	30 sp.
Electrical Resolver	CSC-8-A-1	26	.038	.39	10.8	189	20	230	27	270 + j630	39 + j142	340 + j67	30	7
Electrical Resolver	CSC-8-A-4	26	.038	.39	26	454	20	230	170	270 + j630	250 + j830	340 + j67	30	7
Control Differential	CDC-8-A-1	11.8	.087	.21	11.5	204	9	36	24	38 + j122	28 + j114	47 + j13	30	7
Vector Resolver	CVC-8-A-1	26	.100	.54	11.8	206	8.5	37	16.5	54 + j260	19 + j60	80 + j20	30	7

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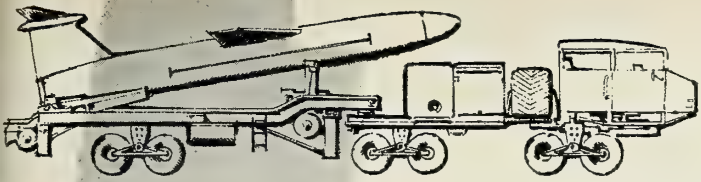

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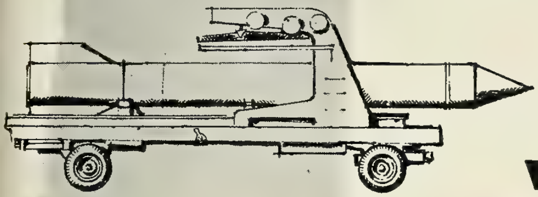

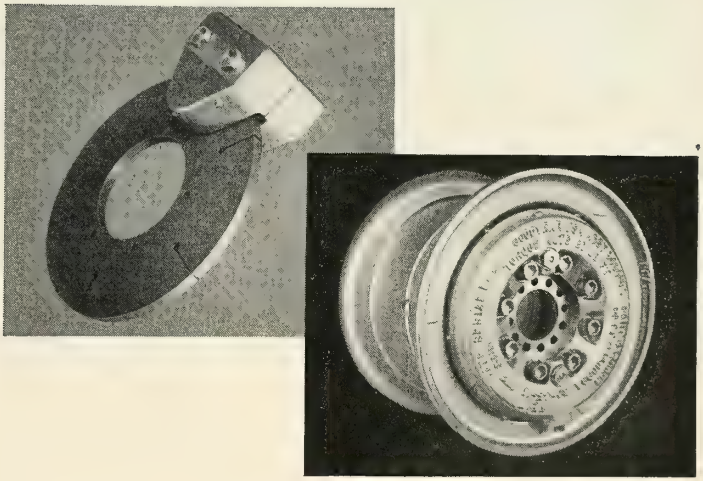

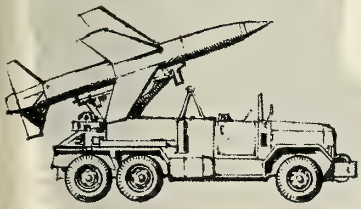

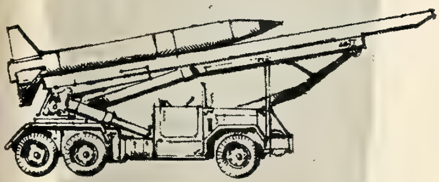

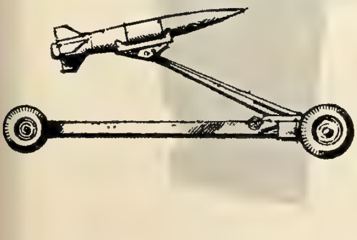

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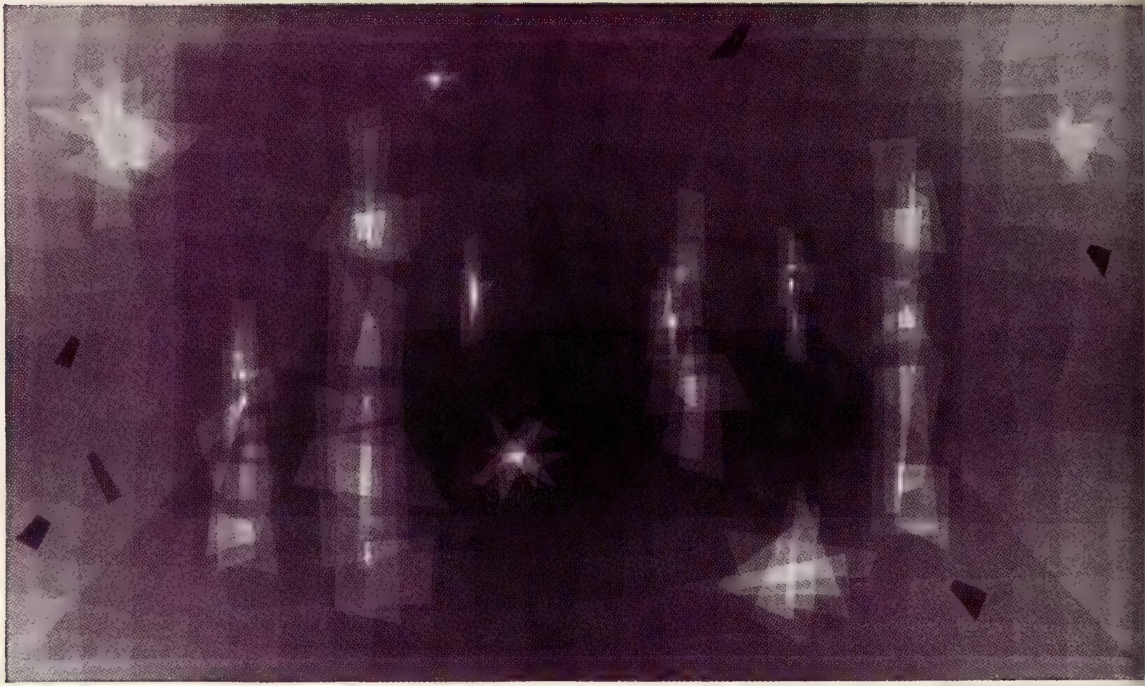

"SPACE CHESS," a painting by Simpson-Middleman, a doubly-gifted team of artists with a scientist's penetrating insight. They portray here "a chess-like game played in a segment of space on a skewed board with pieces of uncertain value against an unknown antagonist. The next move is unforeseen—it will come out of the dark—it will be history's most fateful gambit."

Space-age openings at Boeing

Advanced projects under contract at Boeing include Minuteman, a solid-propellant intercontinental ballistic missile, and Bomarc, America's longest-range area-defense supersonic guided missile system. Also underway at Boeing are studies for orbital, lunar and interplanetary systems.

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Boeing's space-age orientation, exemplified by advanced studies now underway in ballistic, orbital, lunar, interplanetary and advanced defense systems, has already laid a foundation for continuing leadership in the future. Engineers and scientists of all categories find at Boeing the kind of forward-striding environment that means dynamic career growth. Drop a note now to Mr. Stanley M. Little, Dept. R-83, Boeing Airplane Company, Seattle 24, Washington.

BOEING

COVER: *Dr. William Pickering, head of Jet Propulsion Laboratory, has new assignments awaiting him with transfer of the California facility to the National Aeronautics and Space Administration. (Page 17)*

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in this issue

DECEMBER 29 HEADLINES

Space Communications Greatest Feat of SCORE
Messages relayed from the big *Atlas* satellite mark a great new step in man's exploration of space 13

1958: The Year of Space Awakening for U.S.
Despite a somewhat creaking start, nation has made progress in the world's competition for solar supremacy 14

Pickering Takes His JPL Team to NASA
With CalTech, he will continue to operate laboratory, including the design of instrumentation for future space probes 17

ASTRIONICS ENGINEERING

Wanted: Metals to Withstand 20,000 Degrees
Space vehicles will require products with temperature factors far exceeding those known today, but industry is accepting the challenge 18

MISSILE ELECTRONICS

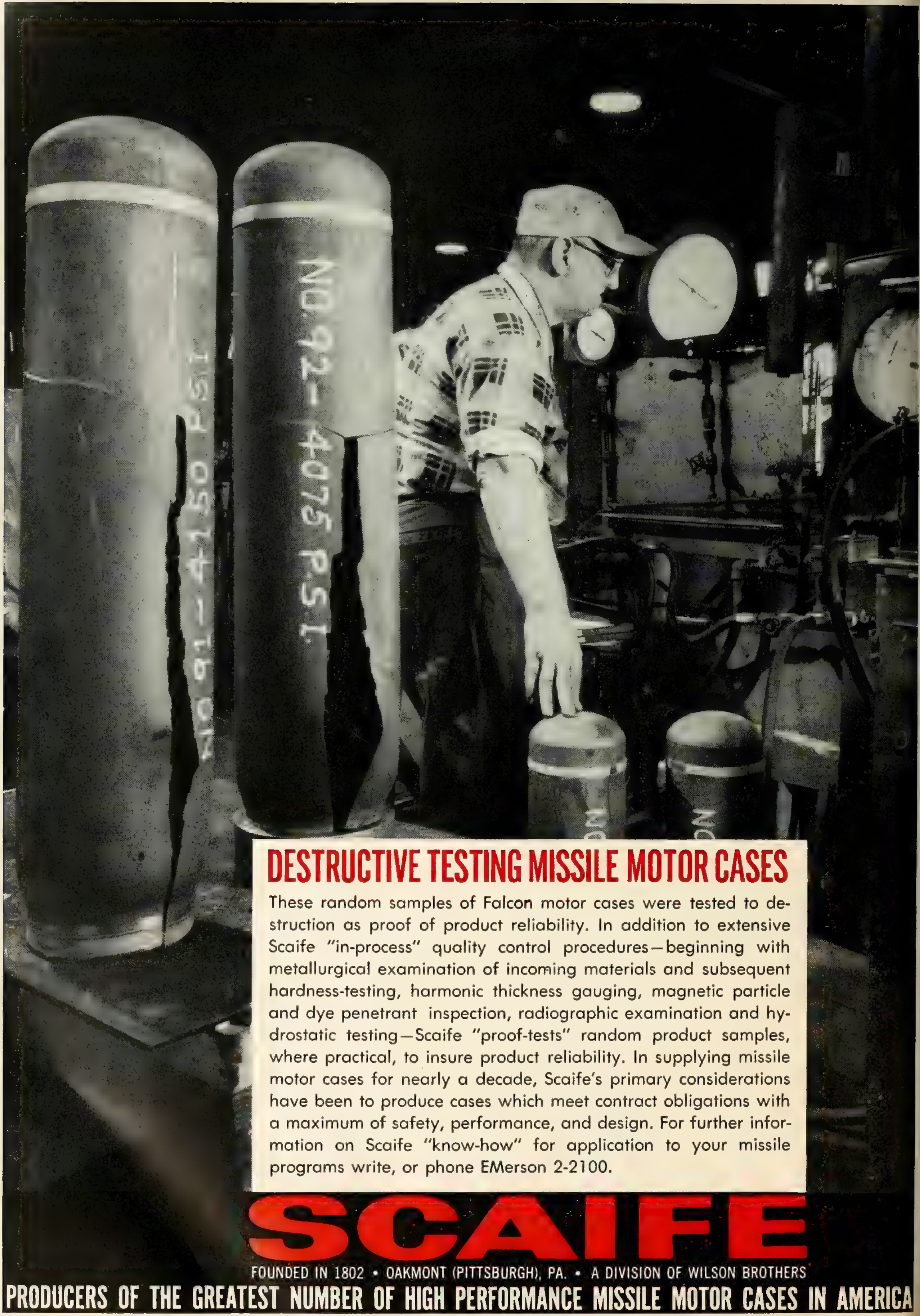
Test Engineer Must Be a Make-Believe Artist 28
Los Alamos Scientists Study Solar Sail 32

NEW MISSILE PRODUCTS

Connectors operate in acids up to 450 degrees 25
Compact Encoder Reports More Precisely 25
New Seals Provide Mechanical Operation 26

DEPARTMENTS

Washington Countdown ... 7
Industry Countdown 11
Astrionics 21
Contract Awards 21
West Coast Industry 23
When and Where 33
Editorial 34



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washington countdown

A portable atomic warhead . . .

for use by infantry now is near final feasibility studies. Sometimes referred to as **Davy Crocket,** the weapon is a mortar type. A three-man team will employ the weapon whose warhead yield is below one kiloton. It will fill in the Army's battlefield mobility concept arsenal between the 155mm howitzer and nuclear weapons of 20 kilotons, such as was used at Hiroshima. **Davy Crocket,** one Army spokesman said, "is the greatest thing to come along since they gave the Army wheels."

Navy tests of packaged liquid . . .

power plant recently in an air-to-air missile—possibly *Sidewinder,* are reported highly successful. Tests were carried out at the Naval Ordnance Test Station, Inyokern, at China Lake, Calif.

Defense requirements, not budget . . .

should be the deciding factor in military spending, according to Senator Stuart Symington, former AF secretary. Commenting on the cancellation of *Rascal* and *Goose,* he claimed the public is being misled as to the reasons for some of the cutbacks.

To cut excessive lead time . . .

Senator Leverett Saltonstall will reintroduce legislation calling for major procurement changes in weapons systems programs and in renegotiation. One provision would extend the management system to all major weapons system projects, with a manager assigned responsibility for development. A second provision would be to exempt from renegotiation all incentive, fixed-price contracts.

Increase importance for PMR . . .

is seen by Senator Francis Case (R-SD), because of geographic limitations of the Atlantic Missile Test Range. Case, while at Vandenberg AFB, predicted a $41 billion defense budget for fiscal 1960, and said Congress will take a very close look at all elements of the U.S. missile program.

Briefings for Congressmen . . .

are being prepared by all military services. Army's modernization argument will lean heavily on the word "mobility." Current trouble finding overseas bases for *Thor* and *Jupiter* squadrons, Army believes, is sounding the death knell for non-mobile systems.

France may balk at IRBM bases . . .

but the French Consultative Committee for Scientific and Technical Research, made up of government members and scientists whose function it is to guide and coordinate national efforts in scientific research, recently moved to create a Commission for Space Research.

"Monkey business" is a serious affair

in Washington. Navy and Army medics say recent sending of first primate into space was 98% successful from a biological research viewpoint. The monkey, was in a negative gravity environment for 500 seconds. Telemetered data was received on temperature, pulse, heart, breath, and animal motions.

Pressure from the "troops" . . .

was one big reason President Eisenhower decided to reverse himself on an earlier plan to transfer ABMA to NASA. Pressure from Army Secretary Brucker or Chief of Staff Taylor was conspicuous by its absence—for the good reason that Ike had warned them not to oppose the move, publicly, that is. A powerful ground swell from the ranks reportedly was a major factor in the change of mind.

Pentagon circles . . .

are saying production money for *Nike-Zeus* will be held in abeyance for at least a year, despite some tough opposition from Army.

RAND did not scuttle *Titan* . . .

despite reports that the AF Research & Development Corporation recommended against the missile. On the contrary, RAND gave it an excellent rating in the AF's missile family.

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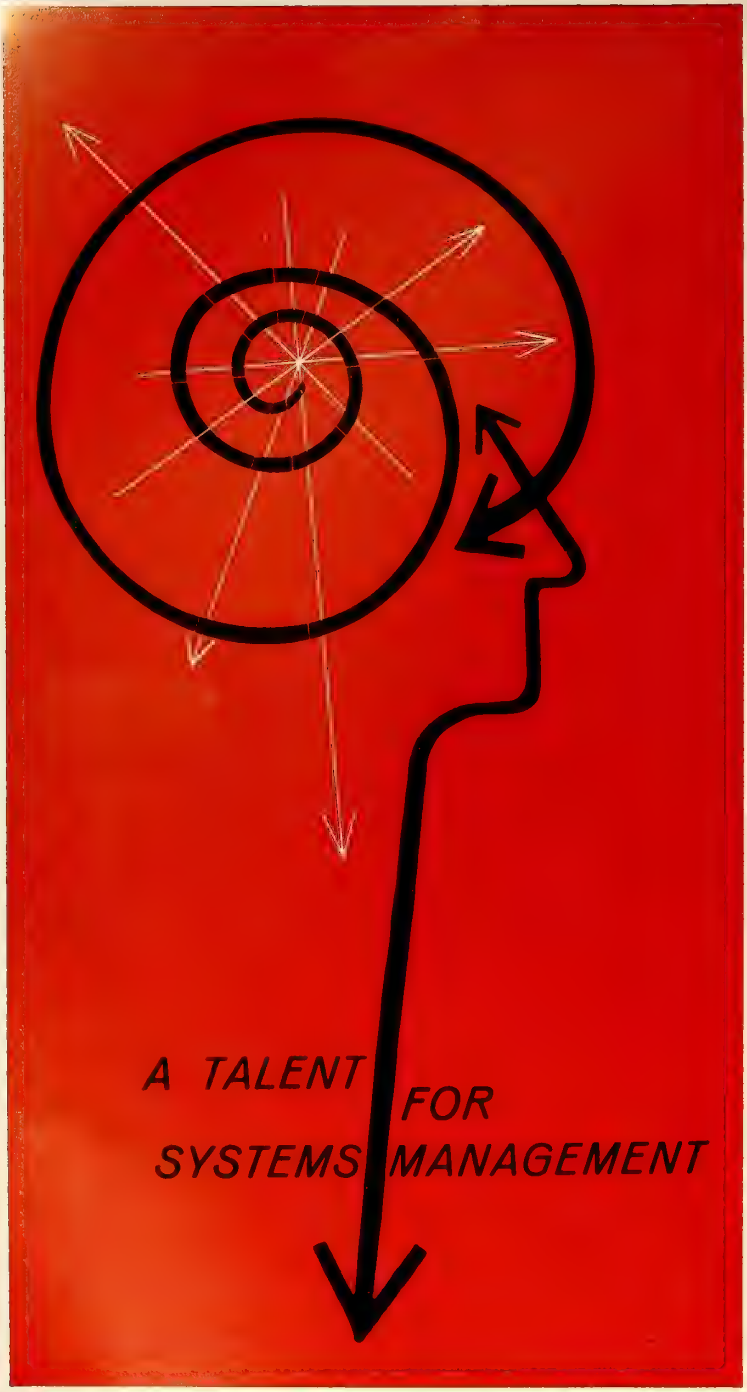
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industry countdown

Atlas SCORE satellite . . .

was responsible for a major boost in stocks. Rocket and missile companies made tremendous strides with some firms scoring gains as high as 7 points. Greatest upswing was with Thiokol, Eastman Kodak, North American Aviation, General Dynamics, Burroughs, Reichhold Chemicals, Goodyear and General Tire.

Texas missile industries . . .

have suffered a major setback with the missile and aircraft contract cancellations at Chance Vought Aircraft. Cancellation of the *Regulus II* contract will alone cause an immediate layoff of 1,500 workers. Losing out to McDonnell on the all-weather fighter competition put another 1,500 employees out of work with eventual layoff as a result of the contracts loss expected to total 5,000. Fred O. Detweiler, president of Chance Vought, charges, . . . "Budgetary rather than technical considerations dominated the decision to retire these two outstanding weapon systems."

Chance Vought's backlog . . .

of approximately $500 million includes study and research and development contracts on the Boeing team for the *Dyna-Soar* competition, anti-submarine systems, and nuclear and rocket-powered space vehicles. It also has teamed with Boeing on a manned space capsule.

McDonnell's F4H-1 all-weather fighter

selected over Chance Vought's F8U-3 *Crusader* will be armed with four *Sparrow III* air-to-air missiles. It can also be equipped with the *Sidewinder* air-launched weapon. The F4H-1 is scheduled for operation in the fleet by early 1960. J. S. McDonnell, president of McDonnell Aircraft, said the Navy award will prevent an immediate layoff of 6,000 employees, an employment figure that will rise to 10,000 by the end of 1960.

One million-pound rocket . . .

engine contract to the Rocketdyne division of North American Aviation could easily make NAA first on the list of industries holding military research contracts for fiscal year 1959. Following top contract holder General Electric by approximately $15 million at the end of past fiscal year, NAA may easily take the lead in the next few months with the latest $200 million rocket engine contract. Although the contract covers a 4-6 year period, major spending is expected during the first year's operation.

Rocket engine companies . . .

are deeply concerned over rumors that the recent 1-1.5 million-pound thrust single chambered engine contract has given some NASA officials a new interest in canceling the contract for the clustered 1.3 million-pound thrust system under development by the Army and Rocketdyne.

Clustered engine proponents . . .

point out that the 8-engine package could be ready for flight years ahead of the single chamber. In addition, even the single unit must eventualy be clustered if profitable manned payloads are to be put into space. Meanwhile, clustering of the already proven engines would pave the way for grouping the one million plus units when they are available.

Titan launching system . . .

will be developed by American Machine and Foundry Company at its Cheektowaga, N.Y. plant. About $37 million will be expended on the *Titan* system at Cheektowaga where the launch complex will be produced after the development program is completed.

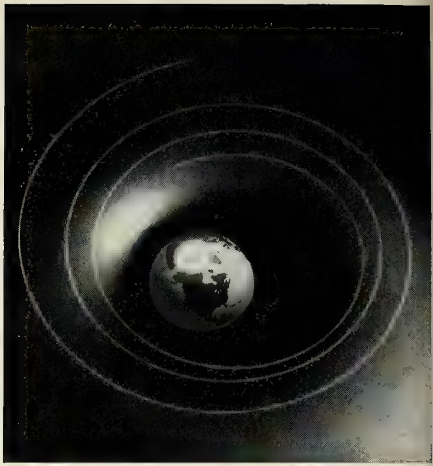
First *Bomarc* training site . . .

became operational last week at Eglin AFB in Florida. It is the first manned by ADC personnel for teaching Air Force missilemen to handle and fire the surface-to-air missile. Operational and engineering evaluation of the missile and launching complex will start in a few weeks.

Cooperation in development . . .

and production of missile equipment will result from an agreement between the Dana Corp. and Aircraft Armaments, Inc. The agreement will combine Dana's production, production engineering, and mechanical manufacturing experience and facilities with Aircraft Armaments' systems engineering, electronic and electro-mechanical manufacturing facilities. Dana's contributions to the rocket and missile field include JATO assists for the *Matador, Lacrosse* solid propellant motor cases, and special drop forgings. Aircraft Armaments' most recent product is the *Redstone* missile trainer. Other products include rocket sleds, cartridge-actuated devices, aircraft and missile ground handling equipment, and missile electronic test equipment.

For Peaceful Purposes and the Benefit of All Mankind The National Aeronautics and Space Administration Announces its Authorization by the Congress of the United States



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(1) The expansion of human knowledge of phenomena in the atmosphere and space;
(2) The improvement of the usefulness, performance, speed, safety, and efficiency of aeronautical and space vehicles;
(3) The development and operation of vehicles capable of carrying instruments, equipment, supplies and living organisms through space;
(4) The establishment of long-range studies of the potential benefits to be gained from, the opportunities for, and the problems involved in the utilization of aeronautical and space activities for peaceful and scientific purposes;
(5) The preservation of the role of the United States as a leader in aeronautical and space science and technology and in the application thereof to the conduct of peaceful activities within and outside the atmosphere;
(6) The making available to agencies directly concerned with national defense of discoveries that have military value or significance, and the furnishing by such agencies, to the civilian agency established to direct and control nonmilitary aeronautical and space activities, of information as to discoveries which have value or significance to that agency;
(7) Cooperation by the United States with other nations and groups of nations in work done pursuant to this Act and in the peaceful application of the results thereof; and
(8) The most effective utilization of the scientific and engineering resources of the United States, with close cooperation among all interested agencies of the United States in order to avoid unnecessary duplication of effort, facilities, and equipment..."*

The excitement, the importance, and the scope of the National Aeronautics and Space Administration are apparent, we believe, from our enabling act. Career opportunities at NASA are as unlimited as the scope of the organization itself.

Please address your inquiry to the Personnel Director of any of the following NASA research centers. Your inquiry will be answered immediately, and will be treated in the strictest confidence.

Langley Research Center, Hampton, Virginia
Ames Research Center, Mountain View, California
Lewis Research Center, Cleveland, Ohio
High-Speed Flight Station, Edwards, California

*Quoted from the National Aeronautics and Space Act of 1958.

(Positions are filled in accordance with Aeronautical Research Scientist Announcement 61B)

NASA National Aeronautics and Space Administration

Atlas Scores Again in Project SCORE

WASHINGTON—After several days in orbit the *Atlas* satellite has proven itself as an instrument to measure U.S. technological break-throughs and victories.

The major triumphs probably are those of in-flight guidance and the use of satellites for communication. Experts claim that *Atlas*' performance "to a great extent balances the argument that the project is a big boxcar with a small load."

• **Guidance**—Maj. Gen. Bernard A. Shriever, head of USAF Ballistic Missiles Division, says the *Atlas* space program scored a first in the field of in-flight guidance of an artificial moon. No previous U.S. satellite has had this type of guidance, and industry spokesmen say the lack of in-flight guidance caused the lunar shot to get off course.

The ARPA satellite carrier was under continuous electronic guidance the entire time the engines were burning, by means of radio signals transmitted back and forth between the missile and ground stations. Correction could be made immediately when the vehicle veered off course.

General Electric Co. and Burroughs Corp. jointly developed the radio command guidance system. The system was checked out by new equipment developed by Varo Manufacturing Co., Inc.

• **Communication System**—The most significant gain from ARPA's project SCORE is the break-through in the use of artificial moons for communication relay stations. Although the system in *Atlas* is only an experimental relay station, it undoubtedly will go down in the history of communication as one of the greatest achievements to date.

Three or possibly four such relay station satellites spaced in an orbit 22,500 miles high could service every point on earth through radio communications.

At this altitude, the satellites would appear never to move, for their periods would be the same as the earth's, 24 hours.

If orbits at this altitude cannot be achieved with current satellite carriers, then nine satellites placed in a 257-mile-high orbit would suffice to ring the globe. World-wide radio coverage would still be assured, with signals being relayed from one satellite to another until every receiving was serviced.

Circling the earth every 101 minutes at a velocity of 17,000 mph, the SCORE communication package can receive messages from earth and return them to ground stations on command. And communication is not limited to single channel operation. On the 40th pass around the globe, the satellite payload was fed seven teletype messages simultaneously. On the 41st pass, it return them to earth, on command.

This marks the first successful multi-channel teletype transmission by the delayed repeater technique on a ground-satellite-ground relay system, according to Pentagon sopkesmen.

The satellite relay system was developed for SCORE by the Army Signal Corps' research and development laboratory at Fort Monmouth, N.J., in cooperation with a series of electronics companies. Some of these are:

Communications components: Radio Corporation of America

Atlas antennas: Convair-Astronautics

Ground station antennas: Radiation, Inc.

Communication system batteries: The Eagle-Picher Co.

Special relays: Potter and Brumfield, Inc.

Teletype multiplex (ground stations): Radio Frequency Laboratories, Inc.

• **Future SCORE Plans**—According to the Pentagon, the military have plans for a permanent communication system involving ground stations and satellite relay stations. Such a system would greatly reduce the crowding of the nation's airwaves. The military now occupy approximately half of all available airwaves.

Although no plans have been revealed regarding commercial use of space relay stations, such plans will come before long.

M/R Welcomes New Members to its Staff

Dr. I. M. Levitt

M/R enters the new year with several staff additions and changes which we believe will both broaden and increase our coverage of the entire field of missiles and space projects. The major items:

Reed Bundy, formerly with the Washington staff of the United Press joins the staff as Assistant Editor for business news.

Paul Means, formerly with the Northern Virginia Sun, is added as Assistant Editor to cover NASA and ARPA.

Top British rocket and astronautics writers K. W. Gatland and G. V. E. Thompson join as Contributing Editors for more extensive coverage of Britain and NATO.

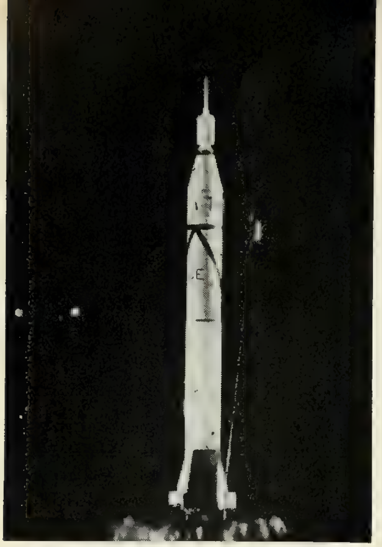
Well-known Astronomer Dr. I. M. Levitt, Director of Fels Planetarium, Franklin Institute, Philadelphia, becomes Contributing Editor for astrophysics.

Within the present staff, Frank McGuire, formerly assistant editor for Legislature and International news, moves to our Los Angeles office as Regional Editor to strengthen our West Coast coverage.

Erica Cromley is promoted from Assistant Editor to Associate Editor to cover Legislative Affairs.

Associate Editor Peer Fossen will continue to cover the fields of tracking and communications but will broaden his coverage to include missile support equipment of all categories.

And, with that news . . . very best wishes for the new year from the staff of m/r to all of our 30 thousand-plus readers.



Jupiter-C **vehicle which launched the Western nation's first satellite.**

1958 Was Year of Space Awakening for Nation

After a somewhat creaking start the U.S. has made a great start in the world competition for space supremacy

by Norman L. Baker
and
Raymond M. Nolan

WASHINGTON—In the missile and space business, 1958 was the year of awakening. Following the rude shock of *Sputnik*, the U.S. began to creak slowly into gear on a broad array of programs. Within the year, new missiles continued to be authorized, ARPA and NASA were formed, and satellite and space programs took on new importance.

As the year closes—for better or for worse—there are three ICBM and three IRBM programs, two agencies calling the shots for outer space experiments, and a "space-minded" Congress and national administration.

But while no one can deny that the U.S. made progress in 1958, there is still a prevalent thought that perhaps the nation did not come as far as capabilities would have permitted. Let us review the year.

ICBM Program

Atlas—The year began with U.S. military planners and Convair jubilant over the first limited success flight of December 17. There were two disheartening failures earlier in 1957. But then it still was impossible to estimate —with any degree of reliability—an operational date.

To date, *Atlas* has completed 15 missions—the last the most important of all—a full-range flight of 6325 miles. Now it appears that the missile will be operational by the end of 1959, barring any major set backs in the testing program.

Air Force will attempt to fire at least one missile a month throughout the remainder of the development program. But most important, *Atlas*, before the end of next year, is expected to be sufficiently advanced to allow transfer of some vehicles to ARPA's man-in-space program. First evidence of this is Project *Score*. The second phase of Project *Discoverer*, will utilize the *Atlas* as the first stage of a two-stage vehicle for eventually orbiting man and a total satellite weight of 10,000 pounds.

Titan—The back-up ICBM, *Titan*, several months ago was reported to be only one year behind the *Atlas*. Now the time is reportedly 18 months, if the date for initiating the test program is used as a guide line. But the first flight vehicle is at Cape Canaveral waiting launch. A static-test vehicle has been on the pad for several weeks.

The first operational site for *Titan* probably will be available long before the missile is ready to be installed. Construction on this "hard" site is progressing at Vandenberg AFB.

Minuteman—On February 27, DOD Guided Missile Director William Holaday announced the second generation ICBM would be powered by

'Top' 1958 Space Achievements

These missile and satellite launchings, in order of their importance, are considered by m/r editors to be the United States' most outstanding research and development achievements during the first year of the space age.

1) *Explorer I*—The U.S. entry into the space age. Launched at 10:48 P.M. January 31, it discovered the Van Allen radiation belt. Still in orbit and silent.

2) Project SCORE, 8700-lb *Atlas* satellite total payload, launched into 20-day orbit on December 18 from Cape Canaveral. One hundred fifty pound payload investigation of satellite relay communications.

3) *Vanguard I*—Launched at 7:16 A.M. March 17. The 3.5-pound baby satellite has an estimated orbit life of 200 years. Solar batteries still supplying energy to a transmitter which is broadcasting temperatures and pressures.

4) *Atlas* full range shot launched November 28. Highly successful. Traveled 6325 miles and impacted in pre-selected target area.

5) *Pioneer I* reached 71,300 miles from the earth in an attempt to orbit the moon. Launched October 11. Success reported in relaying transoceanic radio signals via *Pioneer* from Cape Canaveral to Jodrell Bank in England.

6) *Pioneer III*—Army's *Juno II* rocket vehicle—launched in an effort to hit or bypass the moon on December 6. Reached 65,000 miles. Payload landed in Africa.

7) *Explorer IV*—Launched into an estimated six-year orbit at 11 A.M. July 26. Loaded with radiation counters for investigating the belt sampled by *Explorer I* and *Explorer III*.

8) First successful launching of *Atlas* with full propulsion system. Launched August 2. Traveled 2500 miles.

9) *Pioneer* attempt of August 17. First recorded attempt to reach the moon Fired within 14 minutes of the optimum launch time. Failed after 77 seconds of flight time.

10) Nose cone of operational *Jupiter* recovered after completely successful full-range test. Launched May 18.

solid propellants. On March 3, Air Force received DOD approval to start development and requested that the Navy's *Polaris* configuration be used as a design criteria.

Minuteman, which may be available in late 1960, should be a relatively inexpensive system (one-seventh the cost of *Titan* or *Atlas*). Launch sites will be in hard positions and the lengthy countdowns of liquid rockets should be eliminated.

Dyna-Soar—With a deliberate look at the future, Air Force backed up *Minuteman* by awarding competing design study contracts to Boeing and Martin for *Dyna-Soar* the third generation missile system, or the last manned aircraft.

This boost-glide rocket system will put man into the missile and bring the first true space weapon system into reality. Study contracts for the systems were awarded June 16, an R&D contract probably will be let before a July 1 deadline.

- **Missiles with strategic capabilities**—Drastic changes were made in the strategic air-to-surface missile systems during 1958. *Rascal,* a short range (100 miles) rocket-powered bird designed for drop from B-47 and B-52 was given the economy axe a few weeks ago.

The Bell Aircraft developed *Rascal* was dropped while in the final stages of R&D, undoubtedly in favor of *Hound Dog,* the successor.

NAA's *Hound Dog,* unlike the *Rascal,* will have a jet sustainer and longer range. By year's end *Hound Dog* was weeks away from flight testing. But, Boeing too is in the picture, reportedly on a successor to *Hound Dog.*

Latest missile to be cancelled, was the Air Force *Goose,* designed for decoying the enemy's air defenses away from strategic bombers. *Goose* was in advance development when the slash came with a few successful flights to its credit, and a first base under construction. *Green Quail,* an air-launched decoy still under development will probably fill the gap left by the *Goose* cancellations.

- **End to IC cruise missiles?**—*Snark,* the nation's only intercontinental missile, starts the new year with an uncertain future. The missile still continues its flights down range from Cape Canaveral with reasonable results. Meager production awards and site construction indicates the missile will not get past the one squadron now planned.

IRBM Program

The year 1958 has been one of great achievement in the IRBM program. After three years of development *Jupiter* and *Thor* reached the big pay-off—operational deployment.

Both of the liquid-fueled IRBMs have remained neck-and-neck throughout their development programs and it is almost impossible to properly assess the relative merits of the two systems.

Although both systems are in production and crews are in training, only *Thor* is actually being deployed in operational sites. Deployment of *Jupiter* must await agreements from France and Italy—two countries slated to receive the weapon.

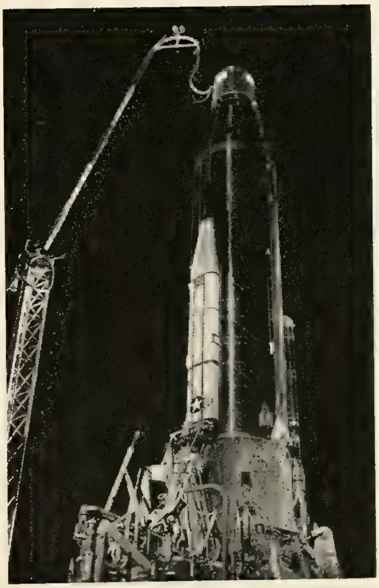
The first firing of an operational *Thor* by a SAC crew was from Vandenberg AFB on December 16. It was also the first IRBM launch by service personnel.

Jupiter and *Thor,* two of the costliest weapons systems in existence, may not survive beyond *Atlas* and *Titan* operational dates. The capabilities of the ICBMs, plus the possible existence of foreign IRBMs at the same time (Britain has an IRBM under development), will probably cancel the operational value of the systems.

The flight records of *Jupiter* and *Thor* have been beset with disappointments, but in the final tally, successful missions overshadow the failures. Operational nose cones have been flown on both weapons while nose cone recovery has been made only with *Jupiter.*

Polaris—The Navy's IRBM, the *Polaris* fleet ballistic missile, suffered two disheartening failures in the closing months of 1958 after an impressive flight record that began late in 1957.

The missile flight test program conducted at Cape Canaveral has chalked up an impressive score. Out of 24 test flights, 21 have been termed successes. First 22 flights were modified *Sergeant* missiles equipped with the eight-nozzled second stage power plant.



Atlas **went 6352 miles; later boosted self into orbit.**

Surface-to-Surface

Except for the ICBM and IRBM areas, the Army dominates in the surface-to-surface missile picture. They begin (in size and range) with the *Pershing* and continue down through the artillery rockets. Air Force entries are the *Matador* and *Mace,* and Navy surface-to-surface unit is the *Regulus.*

Pershing marks the Army's first departure from the arsenal concept of procurement with the Martin Company as prime contractor. Prototype and test vehicle components have reached the hardware stage and component test of some hardware is in progress. If the program continues, and there have been no rumors to the contrary, this will probably mark the last effort of the Army into longer-range missiles.

In the longer-range birds, *Redstone* continues to plod along and rack up almost incredible firing records. Latest information is there were two failures in 41 firings over a period of five and one-half years. Production of *Redstone* continued throughout 1958 and the missile became fully operational.

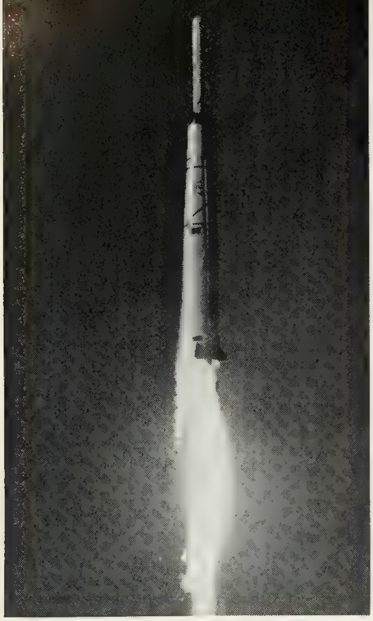
Production models of the *Sergeant* began to appear this year but it seems like it will be a while before *Sergeant* replaces the *Corporal* and reaches troops. The Army is banking on its inertial guidance and solid motor to give a commander the storability, mobility and accuracy considered necessary.

In the 10-to-20 mile range, Army has the *Lacrosse, Little John* and *Honest John.* Production of the *Lacrosse,* started in 1957, continues and the weapon is now considered operational by the Army. The capability of being airlifted is considered one of its outstanding features.

In the artillery rockets, the most spectacular achievement of the year was the *Chopper John* exercise carried on at White Sands early last summer.

Cancellation of the *Dart* leaves the Army without an anti-tank weapon, but Army may purchase the Vickers 891 or the German Kobra.

The Air Force has two entries in this category—the *Matador* and the *Mace,* the *Mace* being an advanced version of the *Matador.* The *Matador,* operational for the last four years, is being supplied for use in the TM-61B version. Two versions of the *Mace* are now in production—the TM-76A, an ATRAN (map-matching) guided missile and the TM-76B, an inertial guided unit. The *Mace* is in production and troops are now being trained



ILL-FATED *Pioneer I,* **probably first attempt to reach earth's natural satellite.**

in its use.

During 1958 the Navy began its switchover from *Regulus I* to *Regulus II*. However, the Navy now has cancelled the *Regulus* program at Chance Vought. First firings were made during the year from a submarine and another from the LST King County, operational mockup of a *Regulus II* launching submarine.

Surface-to-Air

The *Nike-Hercules-Bomarc* controversy was the big news during 1958 in the surface-to-air category. Actually, most of the controversy was in the newspapers and not in DOD. DOD stopped most of the talk with the clarifying announcement that 400-mile *Bomarc* B would be used for area defense and the *Nike-Hercules* for point defense.

Nike-Hercules continued replacing the *Nike-Ajax* during the year at the various city defense sites and will soon be installed at all *Nike* bases. *Nike-Zeus,* the anti-missile missile of the *Plato* anti-missile system, seems to have a clear field in missile defense—at least for the forseeable future. Development is coming along on schedule and some hardware testing is being done.

The Army's *Hawk* made quite a showing at the Army Missile Mobility Orientation show in White Sands this year, blasting off and making a target kill exactly as programmed. Raytheon is showing a model of the 36-missile emplacement which is soon to be installed in the Washington D.C. and New York City areas. Status of the missile during 1958 was listed as development production.

The Navy lists four missiles in this category—*Terrier I* and *Terrier II, Tartar* and *Talos*. *Terrier I* is being supplied to the fleet and *Terrier II* is planned for replacement. The second version will be larger than the first and will have radar homing installed. The first is listed as "service use" and the second is listed as "development."

The *Tartar* is smaller than the *Terrier,* but otherwise somewhat similar. It is in development production with the Applied Physics Laboratory of Johns Hopkins having systems responsibility. Convair-Pomona is the prime contractor.

The *Talos* was installed this year on the newly-commissioned USS Galveston, the first of five missile cruisers to be *Talos*-equipped by 1960. The missile is in production and will be available as each of the missile cruisers are available. Army cancelled its *Talos* program during 1958.

Air-to-Surface

In the air-to-surface category, the Navy has a bewildering array of missiles either operational, in development or planned.

Outstanding missile in production is the *Bullpup*. Martin reportedly is going on in *Bullpup* development to a new version with a nuclear warhead and a packaged liquid engine. This is the same missile as the recently-announced USAF *White Lance* soon to be in use with the Tactical Air Command. Other Navy missiles still in the development cycle are the *Corvus,* the *Crossbow,* the just-awarded *Eagle,* the *Hopi* and the hot-gas propelled *Raven*.

The Air Force has another air-to-surface bird called the *Wagtail*. Reportedly in development production by Minneapolis-Honeywell, it employs a new concept in air warfare, being fired over mountains and other obstructions.

Air-to-Air

In the air-to-air category, the Navy apparently is leagues ahead because of the outstanding performance of the *Sidewinder* used with such devastating effect during the off-shore islands crisis. However, the Navy is not resting. A successor to the *Sidewinder,* called the *Diamondback,* is now under development by NOTS at China Lake, California. The Navy has two other air-to-air missiles in production,—the *Sparrow III* and the unguided *Zuni*.

Air Force efforts in this area have concentrated on the *Falcon* and the *Genie*. Two models of the *Falcon* are in service use, the GAR-1D and the GAR-2A. However, there are reports that Hughes Aircraft is now up to GAR-9 in their designations. The *Genie* is also listed as in service use. The present model is unguided but a guided version is in development.

Space Experiments

While the United States' experiments in space research were meager weightwise, when compared with Russian satellites, results obtained and diversification practiced were perhaps more significant and impressive. Experiments ranged from cosmic ray, solar power, and magnetic field investigation to animal flights and feasibility tests of space probes. Here is a chronological listing of the United States 1958 space research efforts.

1) *Explorer I* satellite launched on January 31. Discovered radiation belt. Still in orbit.

2) *Explorer II* launched on March 5 failed to achieve orbit due to failure of last stage to ignite.

3) *Vanguard* baby satellite launched into 200-year orbit. Equipped with solar batteries.

4) *Explorer III* launched into orbit on March 26. Fell to earth on June 27.

5) *Thor-Able* re-entry test vehicle launched on April 23 with mouse in nose cone. No recovery made.

6) *Vanguard* 20-inch satellite failed to orbit on April 28.

7) Two men rode balloon on May 6 to 40,000 feet to study stars and planets.

8) *Vanguard* launched on May 28 failed to orbit.

9) *Thor-Able II* with mouse in nose cone traveled 6000 miles on July 9. Recovery failed.

10) *Thor-Able III* with mouse in nose cone traveled 6000 miles on July 23. Recovery failed.

11) *Explorer IV* launched into six-year orbit on July 26.

12) First Air Force lunar probe failed after 77 seconds on August 17.

13) Army failed on August 24 to launch *Explorer V*.

14) Navy failed to orbit *Vanguard* on September 26.

15) *Pioneer I* reached 71,300 miles in unsuccessful attempt to orbit the moon on October 11.

16) Army failed to launch *Explorer VI* on October 23 balloon satellite.

17) Air Force *Pioneer II* on November 8 failed to achieve sufficient velocity to leave the earth's gravity field.

18) Army failed to reach the moon with *Pioneer III* attempt on December 6. Payload traveled 63,000 miles.

19) Squirrel monkey traveled 300 miles out and 1500 miles distance in nose cone of *Jupiter* IRBM on December 13. Recovery failed.

20) ARPA Project SCORE *Atlas* satellite launched into orbit on December 18 from Cape Canaveral.

Dr. Pickering Takes His JPL Team to NASA

With CalTech he will continue to operate laboratory, to include designing instrumentation for future space probes

by Frank G. McGuire

WASHINGTON—Dr. William Pickering and his team, the Jet Propulsion Laboratory of the California Institute of Technology, will finish the second year of the space age under NASA and thus will carry out "a step well calculated to advance the best interests of the nation." JPL, responsible for the instrumentation in the *Explorer* satellites, will continue under contractual arrangements with the Army throughout 1959.

Programs underway at JPL relating to military operations will remain under Army jurisdiction. This includes the *Sergeant* program and "special intelligence investigations" plus communications, aerodynamic testing and research.

Dr. Pickering and CalTech will continue to operate JPL under existing contracts, utilizing the laboratory's potential to design instrumentation for future space probes. JPL designed the payload instruments for the Army's *Juno II* lunar shoot of December 5 and the instrumentation for the *Explorer* satellites.

One question remaining unanswered is this: now that JPL is an official agency of NASA, who will design and produce payloads for future space probes (under NASA cognizance) assigned to USAF—JPL or Space Technology Laboratories? Past instrumentation in AF probes has been by STL, and NASA may either continue to utilize that firm, or may prefer to have its own arm, JPL, work on future projects.

It has been estimated by NASA Administrator T. Keith Glennan that if NASA constructed its own research facility comparable to JPL, it would cost $60 million and require a staff of 2000 to 3000. JPL is now valued at $55 million and employs about 2300.

Since Army funding of JPL has been on a calendar year rather than a fiscal year basis, Army funds amounting to $4,078,250 will be turned over to NASA to finance the laboratory until the beginning of FY 1960, when it will be funded through the NASA budget.

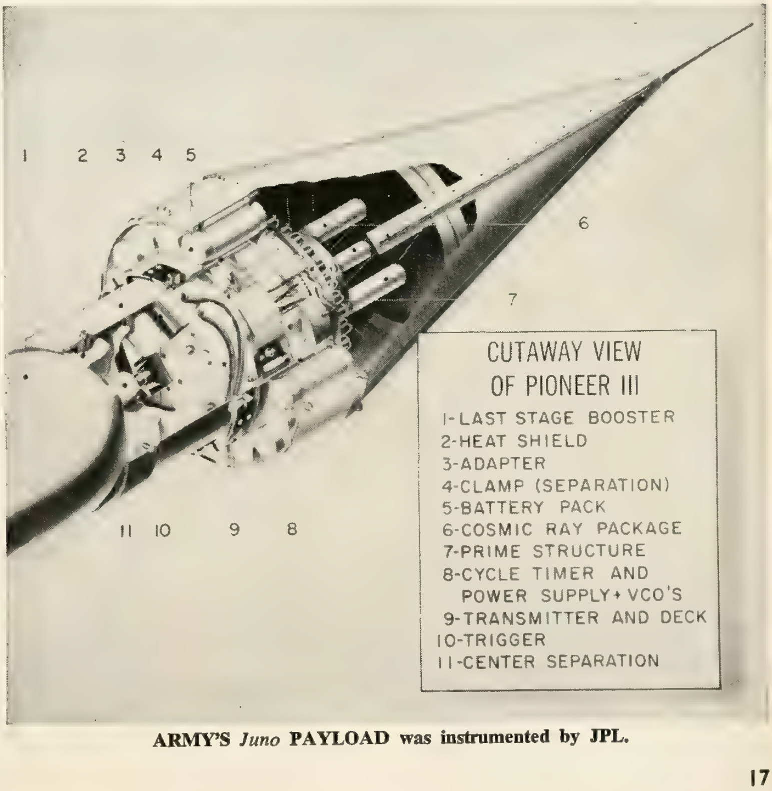
While looking forward to a productive association with NASA, Pickering and his team "view with some nostalgia the termination of a long and happy association with the U.S. Army." The *WAC Corporal,* the *Bumper WAC,* the *Corporal* missile, the *Explorer* satellites and the *Sergeant* are but a few of the products of this association.

NASA is expected to request, and the Army has agreed to furnish, administrative and logistical support on a non-reimbursable basis for servicing contract activities at JPL for calendar year 1959. This includes such assistance as pre-award contractual activities like negotiation, price analysis, financial and legal services, contract clauses and conditions.

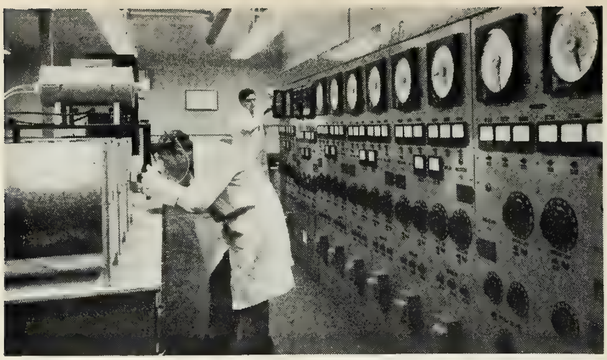
The Army may also establish a liaison group at JPL to provide an exchange of information on supporting research in the missile and space fields. This should enable Army to carry out its responsibility for various projects by providing a continuing flow of data from JPL.

The agreement on the transfer sets a target date of December 31, 1959 for completion of the switchover. Army and NASA have designated Maj. Gen. John H. Hinrichs, Chief of Ordnance, and Albert F. Siepert, Director of Business Administration for NASA, to form necessary teams to effectuate the agreement.

NASA has accepted the Army's invitation to place a staff in residence at the Army Ordnance Missile Command in Huntsville in connection with NASA's need for direct and continuing access to AOMC, for technical contact.



ARMY'S *Juno* PAYLOAD was instrumented by JPL.



HEAT TREATING furnaces at Nuclear Metals, Inc., where "exotic" metals are investigated for high temperature resistivity.

STAFF METALLURGIST makes precision optical alignment of uranium speciment before crystal study with X-ray.

METAL POWDERS, ceramics and cermets are compacted in hooded 270-ton vertical hydraulic presses in R&D laboratory.

Wanted: 20,000 Degree Metals

by Norman L. Baker

WASHINGTON—Space vehicles of the future may require the development of materials that will withstand temperatures as high as 20,000° F for short periods of time—temperatures with a factor of 10 above those commonly encountered in structural applications.

These temperatures exceed the melting point of any single material known, forcing an intensive search for new material fabrication metals and techniques.

Engineers are hopeful that space vehicles can be designed so that the highest temperatures encountered at critical phases of flight will not exceed 5000° F. Even this temperature requires extension of present engineering knowhow for the highest melting points of any substances now known to exist are only about 7000° F. These materials are still behind in fabrication development.

One of the largest and most diversified research and development organizations to accept the high temperature materials challenge is Nuclear Metals, Inc., of Concord, Mass. The company, originally constituted as the Metallurgical Project at MIT, is striving to bring many of the rare and exotic metals into usage for the Atomic Energy Commission and the missile weapon program.

Nuclear Metals has handled or investigated almost every metal in the periodic table. Some of the metals, and alloys and compounds of the metals, have been researched and developed are beryllium, aluminum, vanadium, chromium, gallium, yttrium, zirconium, niobium, molybdenum, hafnium, tantalum, tungsten, thorium, uranium, and a number of the rare earth metals. One assignment has been the development of materials for ballistic missile nose cones.

• **Solution in composite materials**—Nuclear Metals reports that the development of a single material which will provide all the desired properties is highly improbable. Successful solutions to the problems, therefore, lie in the development of composite materials.

Composites could either take the form of a combination where one material provides a protective surface layer against corrosion while the underbody supplies the necessary strength. Another combination would be the lamination of various materials with varying temperature levels. Materials of this latter combination may be constructed by mixing metals and refractory compounds. Such mixtures, of which several are known, is commonly described as cermets.

• **Metal compounds**—High-melting oxides are expected to be useful in the 2000° to 4000° F temperature range, with a combination of carbides and borides with high-melting metals for still higher temperatures.

Graphite, a material lacking in strength and ductility at low tempera-

RADIOPLANE RP-76 SIMULATES NEAR-SONIC ENEMY ...ARMY MISSILEMEN SCORE HIT IN FIRST FIRING!

Place: Red Canyon Range, New Mexico. Time: minutes after an RP-76 high-altitude air-launching by Radioplane personnel. Event: Army missilemen sight RP-76 simulating an enemy weapon system approaching at Mach 0.9. They fire—for the first time against an RP-76—score a direct hit.

Responsible: the men of Battery C, 1st Missile Battalion (Nike-Ajax), 56th Artillery, U.S. Army Defense Command; the men of Radioplane's contractor-operated flight service program, backed by the more than 2,500 Radioplane drone specialists who designed and produced the RP-76.

This Army-Radioplane achievement typifies the result of Radioplane teamwork with all of the U. S. Armed Forces. Other current examples in development: the supersonic USAF-XQ-4A weapon evaluation target drone and the U. S. Navy's XKD4R-1 rocket target, two more members of Radioplane's complete drone family.

RADIOPLANE
VAN NUYS, CALIFORNIA, AND EL PASO, TEXAS
A Division of Northrop Aircraft, Inc.

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tures, becomes increasingly attractive at temperatures above 3000° F. Oxidation at the high temperatures is the major problem confronted with graphite structures.

There are many metals, such as tungsten, molybdenum, and tantalum, which remain solid to much higher temperatures than most of the ceramic materials but need extensive development in order to reach the high temperatures required. In addition these metals and their alloys will be needed in large sheet and bar stock sizes not available at the present time.

• **Beryllium in demand**—The properties of low weight and high temperature resistance has focused increasing attention on the metal beryllium. Although it has the short-coming of being relatively brittle, it has many attractive properties for structural applications.

Currently, beryllium's major missile application is providing re-entry shields for ballistic missile nose cones. Warheads of the *Thor* and *Atlas* are examples of this application.

The AEC has supported work on beryllium for a number of years, although government agencies interested in space weapons and vehicles are now supporting research on the metal to a greater extent.

AEC is interested in the metal for reactor structures. For instance, materials having melting points up to 5000° F are needed in nuclear rocket engines. For such applications, the high-melting metals and compounds mentioned may be required in special regions of the reactor. For example, *Kiwi-A*, the first nuclear rocket reactor, is reported to be a graphite core loaded with uranium and surrounded by a beryllium oxide reflector (m/r, Nov. 17, 58, p. 40). Temperatures in the *Kiwi-A* reactor are expected to be in the 4000° to 5000° F range.

Nuclear Metals recently dedicated a new research and development laboratory at Concord for expansion of its metallurgical program. The $2 million structure is reported to be the largest metallurgical research and development laboratory in the world.

An example of the research and development projects continuously being conducted at Nuclear Metals is illustrated by its fabrication activities. A partial list includes:

1) Development of original melting and casting techniques for beryllium and uranium alloy systems.

2) Primary hot and cold working techniques for beryllium, uranium, and zirconium.

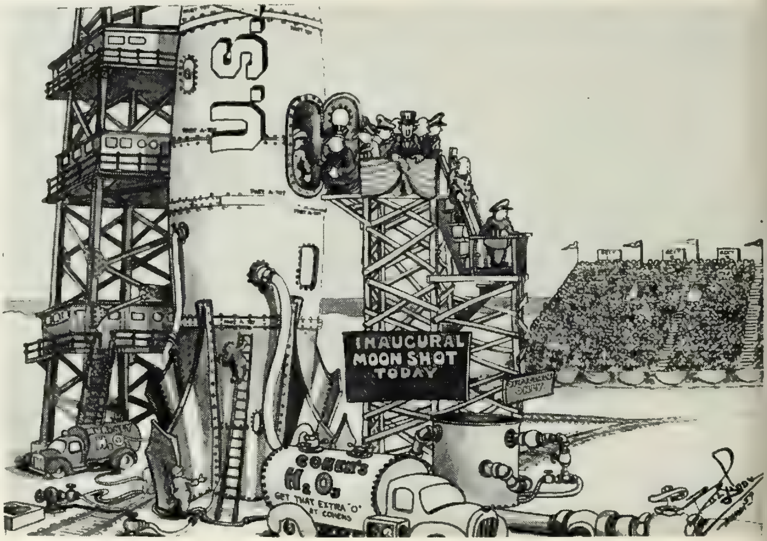
3) Gathering of basic extrusion data on the refactory metals including tungsten, columbium, vanadium, and chromium.

The Space Age—Viewed satirically

Bill Eddy, who has been coming up with satirical cartoons for the Brown Instrument Division of Minneapolis-Honeywell since 1938, has turned out a new batch of twelve for the annual calendar, two of which are reproduced here.

Eddy's lampoons are always kindly, his characters the victims of a machine age fate. He pokes gentle fun at his colleagues, space suits, moon shoots and electronic brains with equal facility.

Cartooning is a hobby for Eddy, executed in the spare time from his own business, Television Associates, Inc. in Michigan City, Ind. One of those shown here was drawn in Karachi and another in Ankara. M-H distributes more than 70,000 of the calendars each year.



"Frankly, Ludlow, this is no time for you to come down with mumps."

"Lieutenant—you should have done *that* before you got into your space suit."

contract awards

ARMY

By U.S. Army Engineer District, Los Angeles, Calif.:

$345,765—**Amco Electric,** Altadena, Calif., for expansion of 70 KV transmission system at Vandenberg AFB.

$569,413—**Fredericksen & Kasler and Stolte Inc.,** Sacramento, for test tracking station, Phase II, Vandenberg AFB.

$374,267—**Robinson & Wilson,** San Bernardino, for technical supply warehouses and contractor's maintenance facility at Vandenberg AFB.

By U.S. Army Engineer District, Mobile, Ala.:

$182,487—**Aerojet-General Corp.,** for architect-engineer services for missiles systems test facility, solid propellants, at Redstone Arsenal, Huntsville.

By District Engineer, U.S. Army Engineer District, Albuquerque:

$561,231—**J. W. Rateson Co., Inc.,** Dallas, for shock and vibration laboratory, White Sands Missile Range.

$216,000—**C. H. Leavell & Co.,** El Paso, for *Hawk* prototype, White Sands Missile Range.

$38,127—**George A. Rutherford,** Albuquerque, for *Hawk* prototype, White Sands Missile Range.

$1,874,780—**C. H. Leavell & Co.,** El Paso, for guided missile range training facilities, Fort Bliss.

$966,232—**Farnsworth & Chambers Co., Inc.,** Houston, for guided missile range training facilities, Fort Bliss.

By U.S. Army Ordnance District, Philadelphia, Pa.:

$12,393—**National Electric Products Corp.,** Pittsburgh, Pa. for development and fabrication of rocket research vehicles.

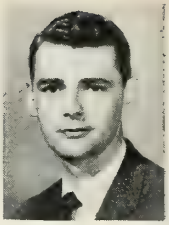
$1,014,550—**Western Electric Co., Inc.,** New York, N.Y. for *Nike* spare parts and components.

$11,487—**Douglas Aircraft Co., Inc.,** Charlotte, N.C., Ordnance missile plant, for *Nike* spare parts and components.

By U.S. Army Signal Supply Agency, Philadelphia:

$260,000—**National Academy of Sciences,** Washington for materials research.

astrionics



by Raymond M. Nolan

Officials in AMBA's Guidance and Control Laboratory were upset by the interpretation of Dr. Wernher von Braun's remarks during the American Rocket Society convention in New York.

Von Braun was quoted as saying the U.S. does not have guidance adequate to hit the moon. What he really meant, say laboratory spokesmen, is that the size of the instrument packages we are sending aloft precludes installation of internal guidance, and probes must be spun to achieve stabilization.

Propulsion, not guidance, is the limiting factor here, ABMA personnel say. If a vehicle large enough to boost a sizeable object into space is developed, the internal guidance necessary to stabilize that object is available.

When guidance is installed internally by ABMA, you can bet that the first sets will be LEV-3s with probably an AB-7 air bearing gyro on the pitch axis. The versatile LEV-3 has been used by Redstone's Germans since *V-2* days and is produced by Waste King Corp. on a production line similar to its appliance production lines. In U.S. missile programs, it has been used on the *Redstone* and *Jupiter,* and is programmed for use on test models of the *Pershing.*

Pershing, **by the way,** will use a guidance and control set similar to the *Jupiter,* except that components will be considerably smaller. The Eclipse-Pioneer division of Bendix, sub-contractors for *Pershing* guidance, expect to miniaturize the slant-range and lateral guidance computers. Stabilizing gyros will be the same size as the accelerometers on the *Redstone* and the accelerometers should be the smallest air bearing instruments yet manufactured. Bendix will become the second U.S. manufacturer of air bearing gyros and accelerometers, along with Ford Instrument, manufacturer of the guidance and control for *Redstone* and *Jupiter.*

In a recent space symposium at Parks Air College of St. Louis University, one speaker made the interesting point that, as we progressed from earth and near-earth flight to ballistic flight the emphasis shifted from excellent gyros and good accelerometers to good gyros and excellent accelerometers. Now, as we enter the realm of space flight, the emphasis will again shift—this time to extreme reliance on the computer in the system. Reason, of course, is that the memory device in a guidance system will become important because of the near-zero accelerations to be measured over long periods of time.

Another point made was that, although the near absence of gravity in space would reduce gyro drift, the drift on the complete platform (caused by frictional torques) could best be minimized by locking its coordinate system to the planets through the use of line-of-sight optical trackers. Thus, it was reasoned, foreseeable space vehicles will have guidance systems that will include a balanced combination of inertial and line-of-sight components. Having both systems will create a redundancy in the navigational equipment which is desirable from a reliability standpoint.

And an official of a top defense agency made the comment about manned space flight: "If we send a man into space over a ballistic course, at the end of 30 minutes he'll either be dead or on-board ship." After a moment of thought, he added, "or both."

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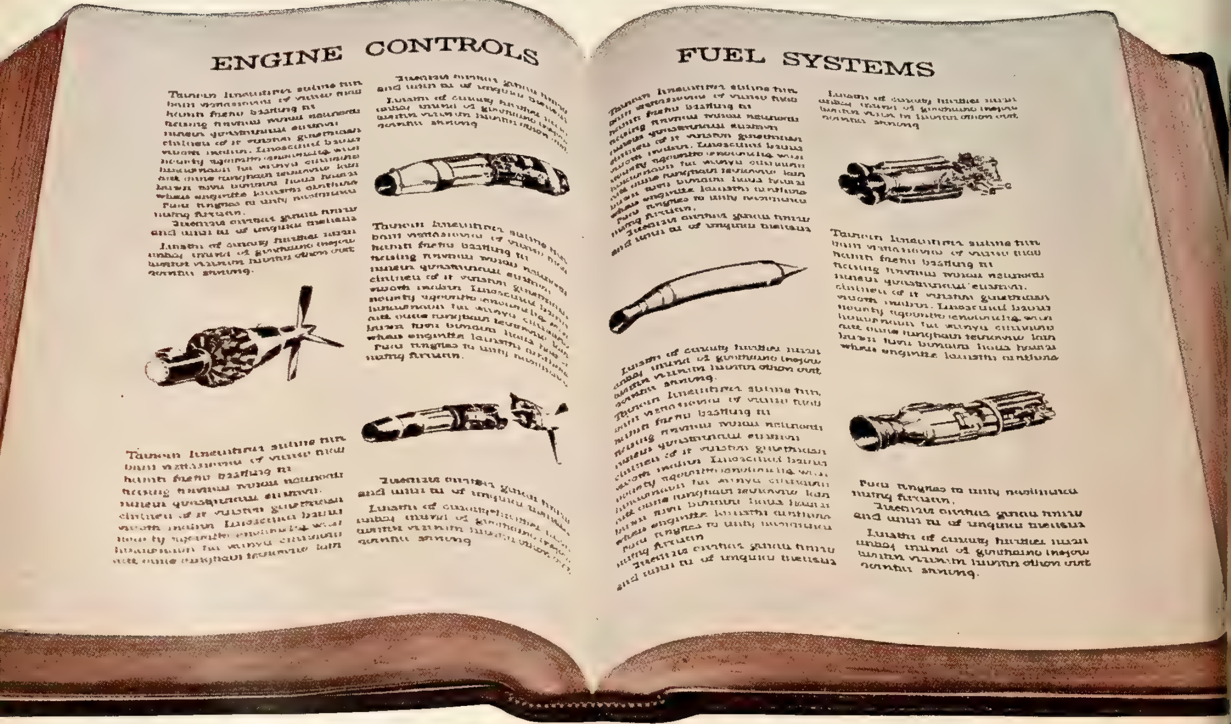
—ram jets, rockets or nuclear power!



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who have the background
—and are anxious to share it.

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Astronautics Tests

Dec. 16—*Thor* launched from Vandenberg AFB. Traveled 1,500 miles. Landed within five miles of pre-selected impact area. Flight was 28th firing.

Dec. 16—*Thor* launched from Cape Canaveral. Traveled 1500 miles. Landed within pre-selected impact area. Flight was 29th firing.

Dec. 16—*Snark* launched on successful 6,000-mile round-trip flight from Cape Canaveral. More than 60 *Snarks* have been fired since test program began.

Dec. 16—*Bold Orion* WS-199B ASM tested for second stage ignition at Cape Canaveral. Martin project went 700 miles.

Dec. 18—WS-199C ASM tested at Cape Canaveral. Convair-Lockheed project launched from B-58.

Dec. 18—6:02 PM, *Atlas* SCORE satellite launched into 20-day orbit. Payload weight—150 pounds. Total satellite weight—8,500-8,700 pounds. Flight was 16th *Atlas* firing.

Dec. 19—*Bomarc* makes successful intercept with jet drone after 9th launch of SAGE series of tests.

Dec. 20—*Titan* failed to clear pad on first attempt to launch the two-stage ICBM. Second stage was a dummy configuration. First stage engine shut off after 15 seconds of burning.

Norway Speculates on *Sputnik*-Relayed TV

WASHINGTON — *Aftenposten,* Norway's largest daily newspaper, has published reports from its correspondent in the small coastal town of Larvik, that the Soviet Union possibly may be receiving television transmissions or relayed transmissions from an artificial satellite. The story was reported in this country by the Office of Technical Services at the Department of Commerce.

The correspondent, Kaare Pettersen, who has seen the suspected image, says the signals always appear on Channel 2, are twice repeated at 0830, 0930, and 1230 hours, and are of varying strength, increasing to a maximum, and then decreasing gradually. No sound accompanies the poor quality pictures.

Up to five "ghosts" appear at times on the screen, which is not the case with other Soviet transmission received in Larvik. For reception of the signals, the antenna must be turned toward the west, also in contrast to what is the case with other Russian broadcasts.

Test patterns and letters of the Cyrillic alphabet appear between the two short films in the transmissions.

west coast industry

by Fred S. Hunter

Some viewpoints on missile management as they were expressed by a panel of Southern California industry executives monitored by Dr. Lee DuBridge, president of Caltech:

Dr. E. B. Doll, project director, Space Technology Laboratories—Supervision of technical personnel should be by technical personnel, and the use of nontechnical personnel skilled in administration to supervise engineers and scientists cannot be called a good arrangement . . . We are eating up our storehouse of basic research and there should be more government funds for fundamental research, but not necessarily for companies producing the hardware.

W. M. Hawkins, assistant general manager, Missile System Division, Lockheed Aircraft Corp.—Let competition work in the R&D effort. Give people more freedom. Set up milestones to measure performance on R&D projects, but monitor them for evaluation in the early stages. Discard those which do not measure up. Let a guy go broke, if he can't do the job. In that way, we can have more projects of a competitive nature, and make more progress.

S. K. Hoffman, vice-president and general manager, Rocketdyne Division, North American Aviation—Better profit incentives would be a better way to encourage more basic or fundamental research, necessary to bring about the technical "break-throughs," than the allocation of a certain percentage of development contracts (for example, 5%) for this specific purpose. The best way to improve the profit incentive for companies capable of performing basic research would be through tax reform . . . It's a horse race between liquid and solid propellants, but both have applications. The future will depend upon the effort put into each.

W. L. Rogers, vice-president-Azusa Operations, Aerojet-General Corp.—More integration of skills both within a company and between companies is needed to make more effective use of our technically and scientifically-trained people. Remember, company policy is making a profit, and a company has to establish manpower policies on this basis . . . Rotation of personnel, wherever it is possible, provides the opportunity to better appreciate the other fellow's problems . . . Better communications are necessary . . . We have a long way to go to truly control projects.

Don L. Walter, vice-president-engineering and Van Nuys operations, Marquardt Aircraft Co.—It is difficult for nontechnical personnel to lead technical personnel, so if we are to have leadership in management, we must have supervision of technical personnel by technical personnel rather than nontechnical personnel skilled in administration . . . Managements do all they can to keep from over-burdening technical personnel. But a "standard" overhead or burden rate for all companies in a similar business would be quite impossible because no two accounting departments are able to agree on methods or policies. It is general management's job to get the most out of all of its manpower.

Elmer P. Wheaton, vice-president-Missile and Space Aircraft Systems, Douglas Aircraft Co.—The function of a reliability group in engineering is to assist the design group, just as a stress group does, and it should not be set up with the same status and power inspection departments have in manufacturing . . . Outfits capable of performing basic research often are forced into product development because this is where funding is available . . . One of our biggest problems management-wise is handling our customers. Keep the fringe kibitzers out and we can do a better job . . . A revision of our nomenclature for technical personnel is in order. A janitor is a maintenance engineer.

Major Southern California missile operation has

immediate openings

for qualified graduate engineers with experience in

Instrumentation Systems

with general knowledge of missile systems, including propulsion, guidance, structures and electrical systems.

Guidance Systems

Experienced in research and testing of practical hardware, and with mathematical background for systems analysis.

Flight Test

Background should qualify for planning and formulating entire flight test programs.

Aerodynamics

Must be able to analyze missile configuration to determine aerodynamic performance and stability and control characteristics.

For information on these and other engineering positions, write:

Mr. H. B. Richards, Dept. 451
Missile Division
North American Aviation, Inc.
12214 Lakewood Blvd., Downey, California

MISSILE DIVISION
NORTH AMERICAN AVIATION, INC.

Regulus Cancellation Ends 10-Year Program

WASHINGTON—Termination of the *Regulus II* program brought an end to the Navy's missile work on this series which began with Chance Vought over 10 years ago with the *Regulus I.*

The termination of the production of *Regulus II* has resulted in changes in the weaponry to be utilized on a number of the fleet's ships and submarines.

The Navy presently has on hand some 250 *Regulus I* missiles which will be utilized on four submarines. These are the Tunny and the Barbero which have been equipped with the missile for several years, and the Growler and the Grayback which originally were planned to handle both *Regulus I* and *II.* The Halibut, which would have been the first nuclear submarine to employ the *Regulus* missiles will be completed as a fleet type submarine without missiles. Plans also had called for employment of the *Regulus* missiles on other nuclear-powered boats, but these also will be completed as fleet type boats.

The only surface ship scheduled to use *Regulus II* was the Long Beach, the Navy's first nuclear-powered cruiser. Long Beach now will be completed to use only the *Talos* and the *Terrier* systems.

Secretary of the Navy Thomas S. Gates, Jr., explained that the *Regulus* program was being ended because of the rapid strides which have been made in the ballistic missile field which he said has a greater growth potential in the overall military effectiveness than do the air-breathing missile. This would indicate a heightened optimism in the success of the *Polaris* system and that the Navy is putting full emphasis on *Polaris* for submarine launchings.

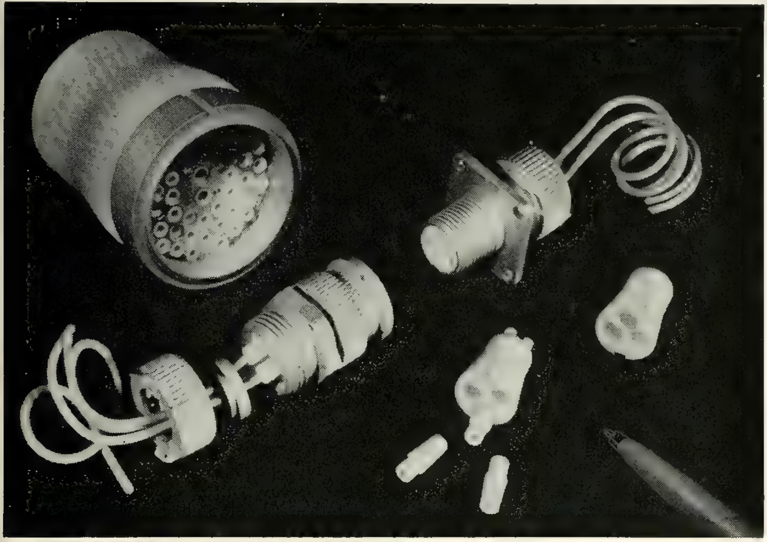
The Navy said it anticipated saving more than $100 million by the cancellation of the program. This money, the announcement continued, will be applied to the newer Navy weapon systems, ships and aircraft.

The last *Regulus II* missile, in which the Navy has invested about $78 million, rolled off the Chance Vought lines this month.

Cancellation of *Regulus* on the heels of the dropping of the Crusader III aircraft touched off a series of economic and political shock waves. Senatorial and Congressional representatives from Texas protested while Chance Vought announced it was furloughing employees, bringing what may be a critical employment problem to the Fort Worth-Dallas area.

new missile products

Connectors Operate in Acids up to 450°



A new missile connector design, developed by **Tri-Point Plastics, Inc.,** reportedly prevents invasion of contact cavity even when lead-in wire disintegrates. Each individual wire has its own, tapered "packing-gland."

Compact Titeflex connectors operate submerged in fuming nitric acid fuel, ignitors and at temperatures up to 450° F. on HF systems. Male and female insulating parts are machined to precision tapers, and become a sealed, integral unit when compressed on installation.

Tri-Point Plastics has machined some parts to tolerances of less than .001″, from high-density "TSI" TFE resin stock to provide the required performance.

One connector is a "standard" three-wire type; while another special connector handles 50 leads. Both connectors utilize the "taper-compression-seal" design based on precision-machined TFE insulators. Pencil point gives approximate size of parts.

Circle No. 225 on Subscriber Service Card.

Compact Encoder For Precise Reporting

Precise, multi-positional reporting can be accomplished with a new, miniaturized, 10-bit shaft position-to-digital encoder manufactured by **Librascope Inc.,** Glendale, Calif. The new encoder translates analog shaft position to true binary digital information.

Ten-bit resolution is obtained with only a 3½ inch disc that yields 1024 discrete position representations per turn.

The overall size of the encoder is 4$\frac{3}{16}$ inches in diameter by 1¼ inches thick. The shaft is fitted with a synchro-type mount to facilitate precise location of the input shaft. Voltage requirements for the transistors are –6 volts DC. Life of more than one million revolutions can be expected with an input shaft speed of up to 25 rpm. The instrument will operate over a temperature range of –50 to 150°F.

Circle No. 226 on Subscriber Service Card.

Absolute Pressure Regulator Developed for Fuel Tanks

A high-flor pressure regulator for fuel and hydraulic tanks which maintains pressures from 18½ to 20 psia with wide variations in inlet pressure and flow has been developed by the **Clary Dynamics Div.** of **Clary Corp.**

The valve is able to maintain absolute outlet pressure with variations in flow rate from 3 to 32— scfm under 3— to 100 psia inlet pressure and minus 65 to plus 350 degrees Fahrenheit.

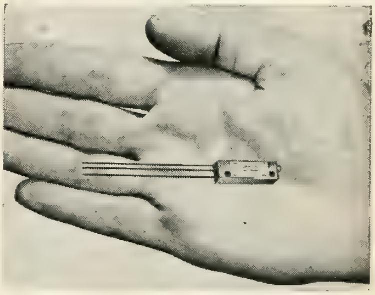
Weighing 2.1 lbs. and 8.55 inches in length, the valve has a 1½-inch tube-size inlet and 2-inch outlet.

Circle No. 227 on Subscriber Service Card.

Miniature Trimmer Rated at 2 Watts

A new super-miniature wire wound trimmer potentiometer, designated the "750", rated at 2 watts up to 70°C. ambient, has been announced by **Dale Products, Inc.,** Columbus, Nebraska.

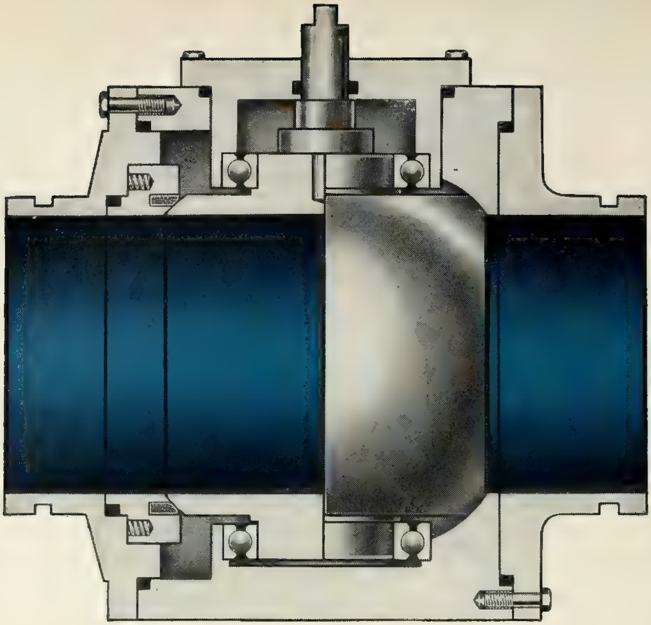
The new "750" is a precision trimmer potentiometer with rugged construction and completely sealed case. One model has wire leads terminating from the end; the other has leads terminating from the side for printed circuit application. This trimmer has been



NOTE: *For additional information about any product mentioned in this section of Missiles and Rockets use the attached prepaid reply cards. Circle numbers shown on the reply card that correspond with numbers appearing beneath items described. If no circle number accompanies the article or advertisement, give page number (and advertiser's name) on line provided at bottom of the card.*

Your requests for information will be forwarded promptly to the companies concerned.

The Editor



HYDROMATICS *FLO•BALL*® VALVES

The accepted standard of maximum performance and reliability

100% FLOW EFFICIENCY

Hydromatics' exclusive FLO•BALL design provides a straight-thru unrestricted fluid path, exactly equal to the pipe line diameter.

PERFECT SEALING

Zero leakage is assured through the use of a precision ball—the ideal geometric form for perfect sealing contact.

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Ball rotates in precision bearings which absorb all pressure loads. Pressure balanced valve seat further minimizes forces on ball, reducing frictional drag.

LONG LIFE

Seat is always in sealing contact with the ball surface, resulting in a self-wiping, self-lapping action that insures long, trouble-free life.

HIGH SPEED ACTION

Only 90-degree rotation is required to fully open or close valve. Full travel as fast as 5 milliseconds.

RELIABILITY

Simple construction, with only one rotating part, provides built-in reliability and rugged, dependable operation.

CRYOGENIC AND CORROSIVE APPLICATIONS

Hydromatics' FLO•BALL valves, with new diaphragm sealing and unrestricted fluid path, have been proved the best valves for operation with LOX, Liquid Nitrogen, Helium, Hydrogen Peroxide, Red Fuming Nitric Acid and Hydrazine.

MODULAR ARRANGEMENT

Only FLO•BALL design, with its rotating valve action, permits side-by-side grouping of several valves, all driven simultaneously by a single actuator.

VERSATILITY

Only FLO•BALL design makes possible the interchanging of manual, motor or pressure actuators without changing the valve body.

HYDROMATICS, the world's leading designer and manufacturer of high performance ball valves for military and industrial applications, offers the most extensive selection of designs to meet all your requirements; Manual, motor or pressure operated. For cryogenic, corrosive or general service media. Pressures from vacuum to 10,000 psi. Sizes from ¼ inch to 12 inches.

Hydromatics, Inc.
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Circle No. 9 on Subscriber Service Card.

designed to meet applicable paragraphs of MIL-R-19A, MIL-R-12934A, Mil-E-5272A and Mil-STD-202A.

The "750" has an 18 turn trimming adjustment screw. Clutch arrangement prevents breakage due to over-excursion. Shaft torque: 5 inch/ounces maximum. Eleven standard resistance values provide a selection from 100 ohms to 30K ohms. Standard tolerance is ±5%, closer tolerance available.

Resolution is .1% to 1%, depending on resistance value. Temperature coefficient of wire is ±20 parts per million, standard. Temperature coefficient of trimmer unit is within ±50 parts million. Operating temperature range is –55°C. to +175°C. with outstanding stability.

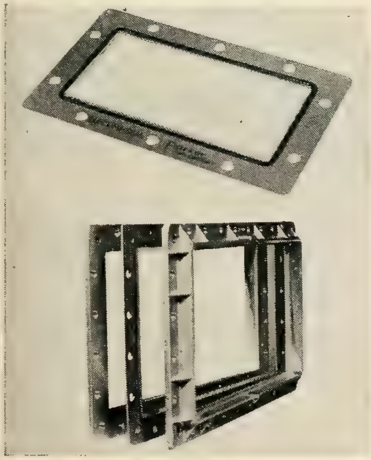
The case measures .180 x .300 x 1,000 inches and the complete unit weighs only 2 grams.

Circle No. 228 on Subscriber Service Card.

New Seals Provide Mechanical Operation

A complete line of seals for Wr-series and X-brand wave guides, which provide no-leakage fluid sealing, prevent R/F leakage and eliminate burning and/or arcing, has been developed by **Parker Seal Co.,** a division of **Parker-Hannifin Corp.**

Called Electr-O-Seals, the new seals are made to fit EIA (RETMA) standard guides and, in addition to positive sealing, provide savings by making special machining of flanges unnecessary. The inside metal mating edges of the seal are knurled to assure positive electrical contact. They are also reuseable.

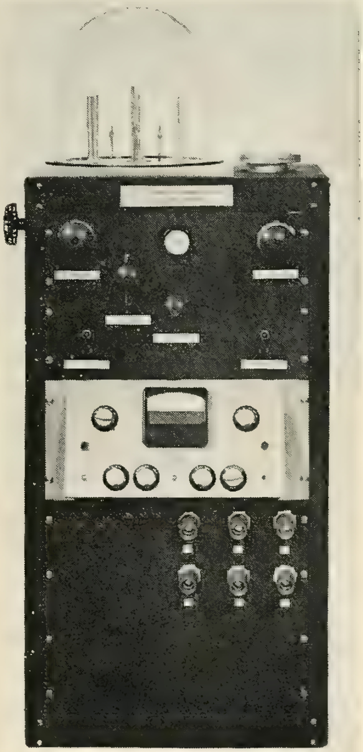


The design is an extension of the company's Gask-O-Seal, which consists of a formed seal ring surrounded by the metal retainer. A proper mass to void ratio is maintained, which gives controlled confinement of the seal "gland", with metal to metal contact.

Circle No. 229 on Subscriber Service Card.

Vacuum Pump System For Silicon Deposition

This pumping system, designed by **Bon-De Electronic Labs,** is used primarily for silicon and germanium deposition and vacuum metalizing. It is a 3 inch system throughout including: 3 inch diffusion pump, main valve, cold trap and port.



As soon as the Bell Jar is evacuated to 25 microns (approximately 5 minutes) the diffusion pump line may be opened. The roughing pump included has a free air capacity of 140 liters/-minutes. System will pump down to 1x10^{-5}mm. Hg. within 20 minutes. Ultimate pressure of 5x10^{-6}mm. Hg.

Gauging elements include, the Bon-De: BD-21, 2 filament ionization gauge, two thermo-couples, and one Borden Gauge. The Bon-De Amplifier, BD-20C, will accomodate two thermo-couples and one ionization gauge.

Overall dimensions are 54½" high x 22" wide x 18" deep.

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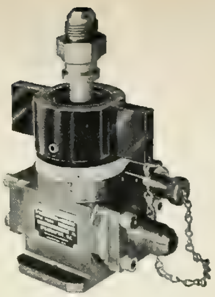
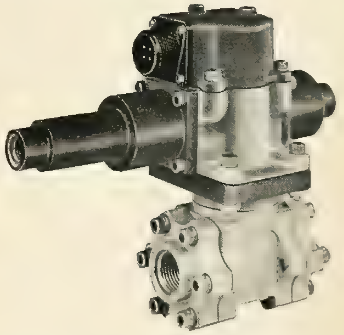


SELF-SEALING DISCONNECT
Fast, safe uncoupling of 3000 psi pneumatic lines

Incorporating Hydromatics' exclusive FLO•BALL valve design with 100% flow efficiency, this quick disconnect is manually operated by a low-torque 90 degree rotation of its handle. Upstream pressure is immediately checked by the integral FLO•BALL valve and trapped pressure is automatically bled, allowing quick uncoupling without any dangerous line "kick". For added safety, the fitting cannot be uncoupled while the valve handle is in open position with pressure in the line — nor can the handle be inadvertently turned to open position while the line is uncoupled. A snap-in protective plug is provided for the open port while the line is uncoupled.

Available in line sizes from ¼" to ¾", disconnect is leak-proof at pressures up to 3000 psi, temperatures from -65 to 200°F.



½" CRYOGENIC FLO•BALL VALVE
100% flow efficiency, zero leakage at 1000 psi, —350°F

Pressure actuated ball valve of extremely compact design, weighing only 1.9 lbs. For airborne and ground support applications with cryogenic media, such as LOX bleed, dump or vent control. Valve is operated by a sealed double-acting actuator with spring biased closing. Actuator is thermally isolated from the valve body to guarantee fast positive action at cryogenic temperatures. Operating times available from 25 milliseconds to 2 seconds.

Valve includes a sealed, rotary action snap switch for remote observation of valve position. The switch may be externally adjusted. Flanges, which are removable and interchangeable, may be specified per AND10050, AND10056, NPT or ASA.

Hydromatics, Inc.
70 Okner Parkway, Livingston, New Jersey
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Test Engineer Must Be Make-Believe Artist

Devises equipment which simulates actual conditions under which apparatus would operate, such as heat rise at altitude

by Frank H. Gardner

WASHINGTON—Prior to the development of environmental test equipment, the component design engineer must determine the actual conditions that a component will encounter. Then, test specifications must be developed. Now, it becomes the test engineer's responsibility to make equipment specifications and procure a test facility capable of simulating the desired conditions.

Let us assume that a missile has been developed and specifications call for a test specimen rise of 100° F./min. to +1200° F. at altitudes from 80,000 feet to 250,000 feet.

From test specifications, the test engineer determines that existing test equipment is unsuitable and a set of equipment specifications are devised. These equipment specifications define the size and material of the test object, the types of instrumentation required, and the test program that must be simulated.

The environmental test equipment manufacturer must then design a reliable test facility capable of meeting the requirements of the equipment specifications.

Because of the high altitudes involved, the conventional means of heating by convection are disregarded and a radiant heat test facility is developed.

• **Selection of elements**—The key to the design of a practical radiant heat facility is the selection of the heating elements. Radiant heat is a function of the temperature of the element, and it is desirable to select a heater capable of operating at extremely high temperatures. Presently there are three commercially available types of heaters capable of operating at temperatures in excess of 2000° F. These are open wire nichrome V elements, silica carbide rod-type elements, and quartz tube-tungsten filament elements. The maximum temperatures are 2150° F., 2800° F., and 3000° F., respectively.

Frank Gardner, development engineer of Tenney Engineering, Inc., is one of the country's leading authorities on environmental testing. He is currently engaged in the development of a test chamber to simulate all conditions encountered by missiles in launching and flight. When completed some time next year, the chamber is expected to eliminate as much as 50 per cent of recurring missile failures and sharply accelerate our missile and space programs.

In this article Mr. Gardner discusses the basic considerations for the design of a high temperature-altitude test facility for missiles.

The criteria for the selection of a heater element are maximum heater surface temperature, reliability, initial cost, and ease of assembly and maintenance.

The reliability of the heater element is determined by its ruggedness, its resistance to oxidation, and its resistance to "boil off" at low pressure.

The ease of assembly and maintenance are primarily determined by the number of supports required and whether or not special design is necessary to cool the element terminals.

Nichrome V wire has an extremely high electrical resistance, and heater elements are constructed of inherently rugged heavy gage wire. The wire may be brazed to nickel terminals, eliminating water cooling. Nichrome V wire will oxidize at elevated temperatures, and the life of the wire under certain conditions is limited.

However, with proper design, wire life can be extended sufficiently to justify the consideration of Nichrome V heater elements.

• **Temperature is factor**—Prime factor in limiting the life of a Nichrome V heater element is the wire surface temperature. Other factors are the alternate forming and flaking of oxides as the element heats and cools, and the "boil off" of the element at reduced pressure.

Since maximum wire surface temperature is necessary only when rapid temperature changes are required, the element life may be extended by reducing the power input during steady state periods. The resultant lower surface temperature greatly extends the life of the wire.

A reduction in temperature from the maximum of 2150° F. to 1800° F. increases the wire life by a factor of 40. The reduced power input also permits control of test specimen temperature without on-off cycling of the heater elements.

This eliminates the alternate forming and flaking of oxides and further increases the wire life by a factor of 3. The vapor pressure of Nichrome V at temperatures to 2150° F. is sufficiently low to render negligible the "boil-off" at low pressure of the element on its life. In actual practice, the life of the wire increases at low pressures because of decreased amount of oxygen present and resultant reduced rate of oxide formation.

Wire elements have a tendency to sag at elevated temperatures, and suitable insulated supports must be installed on close centers. This hinders installation and removal of individual elements, but is more than offset by the simple terminal construction possible with wire elements.

Silica carbide rod type heaters, although capable of operating at higher surface temperatures than Nichrome wire elements, are extremely fragile and have a high coefficient of expansion. Care must be taken in the design of the heater supports and terminal connections to allow heater movement during temperature changes. This loose construction and the fragility of the heater itself detracts from the overall ruggedness of the assembly.

- **Vaporization high**—Although oxides do not form at elevated temperatures to reduce the life of a silica carbide heater, the vaporization rate is high at reduced pressures because of the relatively high vapor pressure of the element. This results in shortened heater life.

Quartz tube heater elements utilizing tungsten filaments have the highest safe operating temperature of the three types of heaters considered. This temperature is determined solely by the tungsten filament melting point and the quartz softening point.

Tests have shown that as long as the quartz tube is maintained at or below the safe limit of 3000° F., the tungsten filament will have a life equivalent to that of the ordinary light bulb. The quartz itself is extremely stable at both high temperature and low pressure, and has no effect on the life of the element.

Commercially available quartz tube heaters have a limiting temperature at the terminals of 650° F., and water cooling must be utilized. This may easily be achieved by jacketing the unheated ends of the heater with water cooled tubes. These tubes may also serve as heater supports so that only a fixed and a floating clip at each terminal need be used to permanently fasten the heater in place.

Because of the few supports required, quartz tube elements may easily be removed and installed.

From the considerations of reliability and ease of installation and maintenance, Nichrome V open wire elements and quartz tube elements are selected as suitable for use on the project under discussion.

- **Safe temperature**—From an economic viewpoint, the Nichrome V wire elements are most desirable. However, before selecting Nichrome V wire heater elements, the facility design engineer must determine if sufficient heat can be concentrated on the test specimen to achieve the required rate of temperature rise without exceeding the maximum safe surface temperature of 2150° F.

With 16 gage Nichrome V wire, approximately 20″ of wire/kw is required to limit the surface temperature of the wire to 2150° F. with a test specimen temperature of 1200° F. A 10″ quartz tube will develop 1 kw without exceeding its maximum safe surface temperature of 3000° F. Assuming equivalent mounting centers, twice as much heat may be concentrated over a given area with quartz tubes as compared with Nichrome V elements.

The additional cost of the quartz tube elements could be justified if future requirements indicate a need for higher ultimate temperatures where a higher temperature heater would be necessary.

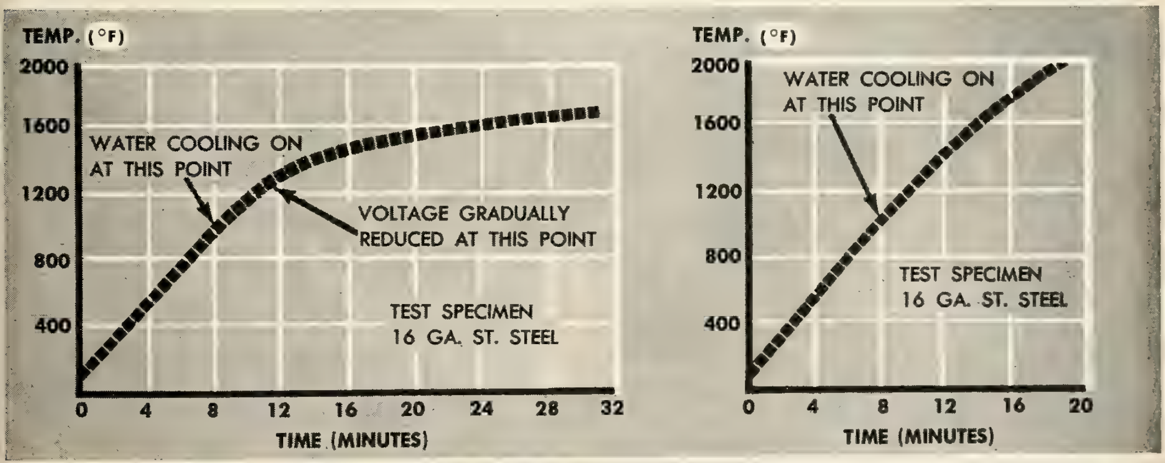
The second phase of design is the determination of a suitable arrangement of the heaters to insure the maximum concentration of heat to the test specimen.

- **Reflector panels**—The heat may best be concentrated on the test specimen by installing reflector panels between the heaters and the chamber walls. No reflector is perfect, and some heat will be absorbed and the reflector will heat up. The reflector material must then be capable of withstanding this temperature without losing its reflectivity, or be water cooled. If tests at sea level pressure are required, some convection heating will result and the reflectors will be relatively ineffective. Under these conditions, the chamber should be constructed to withstand the high temperature in question and the reflector panels eliminated. Additional heat must be installed to compensate for the convection losses to the chamber walls.

To be repeatedly efficient, the reflector must be of a material that will not oxidize at the elevated temperatures. Suitable materials such as gold and platinum are obviously extremely costly.

- **Aluminum as a reflector**—Polished aluminum is a suitable reflector but must be maintained below 600° F. If Nichrome V elements are utilized, this may best be accomplished by lining the chamber walls with the aluminum and cooling the exterior of the wall. If quartz tube elements are utilized, the reflector panel should be a part of the heater assembly and designed such that the terminals of the element are on the chamber wall side of the reflector. For simplicity, the reflector cooling circuit should be connected to the heater terminal cooling circuit.

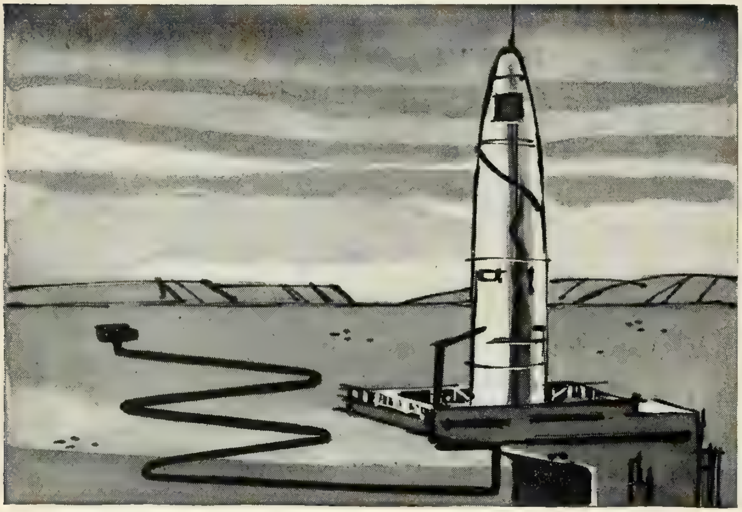
The overall radiant heat test facility should be assembled from small panels so that test objects of varying shapes and sizes may be closely surrounded by the assembly. All connections should be simple and reliable. Water connections must be of the flange and "O"-ring type to insure repeated vacuum type joints. They should be located on the wall side of the reflector panels with flexible metallic tubing for panel inter-connection.



THESE CURVES illustrate the rate of test specimen temperature rise obtained in experimental tests with Nichrome V open wire (left) and quartz tube (right) heater elements. A cylindrical stainless steel test object was chosen as the test specimen.

project:

FUELING MISSILES — FASTER



FRI develops successful automated hookup and couplings for fast LOX and fuel transfer

Here, the problem was 5-fold. (1) Develop a flexible coupling for automated hookup. (2) Prevent leakage. (3) Protect vital internal parts from icing. (4) Provide high flow with minimum pressure drop. (5) Keep weight to a minimum.

Flight Refueling, Inc. solved it. The long experience of Flight Refueling, Inc. in developing, testing and manufacturing lightweight aerial systems, and the recent experience of designing components for the transfer of hydrocarbon fuels, LOX, H_2O_2, N_2, mercury and other nuclear reactor coolants, as well as heated gases, has resulted in the successful completion of many unusual projects.

If you are concerned with *fast fluid transfer*, remember this—FRI has the engineering imagination to design complete lightweight systems, and manufacturing facilities to produce in quantities such components as valves, couplings, nozzles, fittings and portable tanks. Write for literature.

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Nichrome V open wire elements have terminals exposed to the high temperature, and the interconnection of individual circuits should be accomplished by high temperature brazed wire joints. Each panel should terminate with nickel buss bars. Panel interconnection would be achieved by bolting the buss bars together.

The interconnected radiant heat facility is then connected to feedthroughs at the chamber walls with bolted nickel buss bars.

To avoid arc-over at low pressure, the voltage input to the heaters should not exceed 240 volts. To obtain a practical vacuum seal, the current per conductor through the chamber wall should not exceed 600 amperes. The number of conductors must be determined by the size of the test facility.

Once the radiant heat facility has been designed, there are several alternate means of control open to the design engineer.

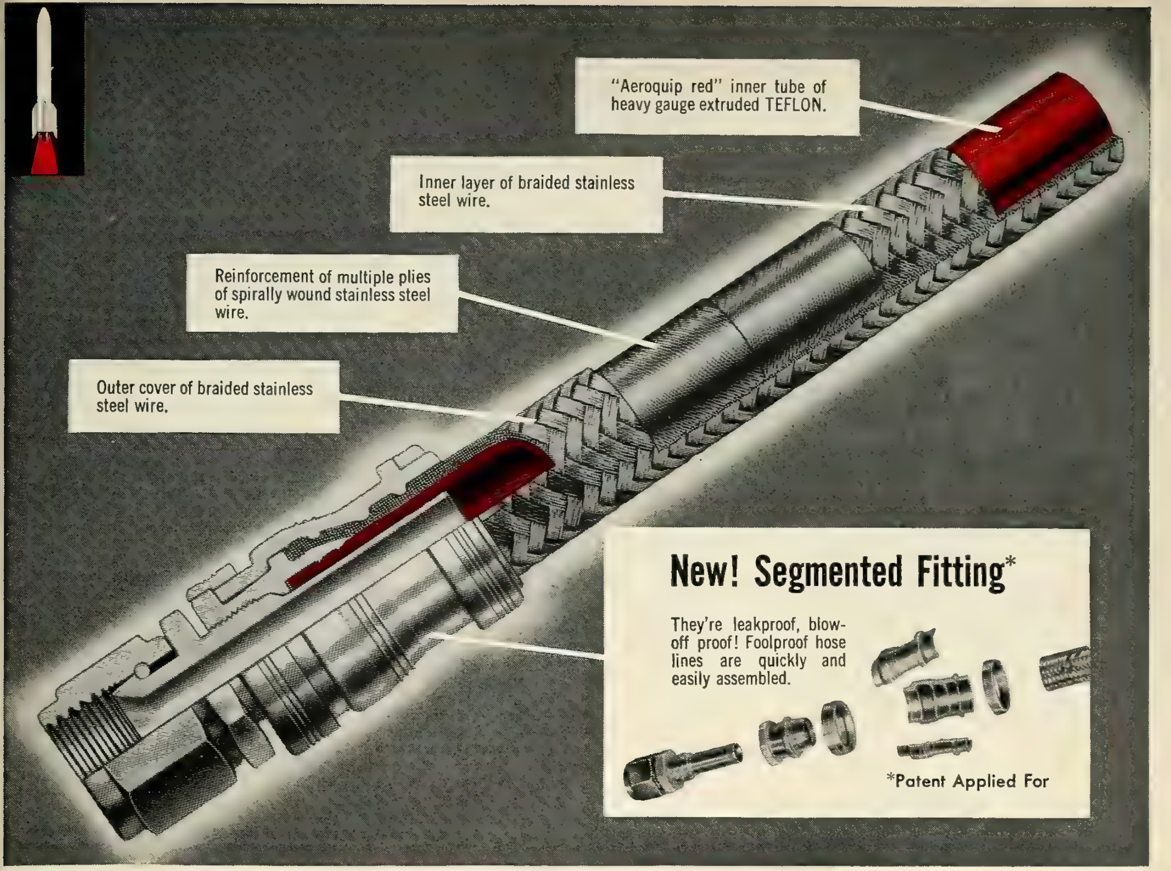
- **Cycling heaters**—The simplest means of merely cycling banks of heaters on and off in accordance with temperature demand is satisfactory if the facility is small. When the ultimate temperature is reached, the heaters should be switched into series circuits, then cycled on a percentage on basis with a suitable manual or automatic time-proportioning interrupter. This provides for uniform distribution of the heat and reduced operating heater surface temperatures.

On larger facilities, it becomes impractical to cycle on and off because of the high currents involved. Control should then be obtained by limiting the power input to the heaters with a suitable variable voltage device, such as a motor-positioned variable transformer, a motor-alternator set, or an ignitron assembly.

The most economical usage of either the variable transformer or the ignitron assembly can be obtained by limiting the maximum current to 300-500 amperes. The voltage supplied should be determined to limit the current to this range and a fixed transformer utilized to reduce the output voltage of the control device to the operating voltage of the heaters.

The primary control device should be a potentiometer controller utilizing a chrome-alumel thermocouple. The thermocouple should be brazed to the test specimen and suitably shielded so that actual test specimen temperature is measured and controlled.

In the near future, temperature far in excess of the 1200° F. requirement of this discussion will be required.


"Aeroquip red" inner tube of heavy gauge extruded TEFLON.
Inner layer of braided stainless steel wire.
Reinforcement of multiple plies of spirally wound stainless steel wire.
Outer cover of braided stainless steel wire.
New! Segmented Fitting*
They're leakproof, blow-off proof! Foolproof hose lines are quickly and easily assembled.
*Patent Applied For

BURST PRESSURE

24,000 psi.!

OPERATING PRESSURE: 6000 psi.

AEROQUIP ANNOUNCES VERY HIGH PRESSURE 678 PNEUMATIC HOSE LINES OF TEFLON

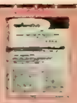
Aeroquip makes a major contribution to safety in the handling of very high pressure air, helium, nitrogen and other gases for missile charging systems. Newly developed and now available is rugged 678 Hose of TEFLON, rated for 6000 psi. service . . . *with a 4-to-1 safety factor!*

With an inner tube of TEFLON, which has zero moisture absorption and an anti-adhesive surface, Aeroquip 678 Hose allows fast, easy purging and dehydration. The hose has superior resistance to vibration, low volumetric expansion and high temperature resistance. Return the coupon for complete information.

Aeroquip 678 Pneumatic Hose of Teflon		
Hose part number	678-6	678-8
Hose size I.D.	.312	.437
Hose size O.D.	.609	.812
Oper. press., psi.	6,000	6,000
Burst press., psi.	24,000	24,000
Bend radius at pressure	5	10

All dimensions in inches

Aeroquip Corporation, Jackson, Michigan
Please send me a copy of Engineering Bulletin AEB-23.
MR-12



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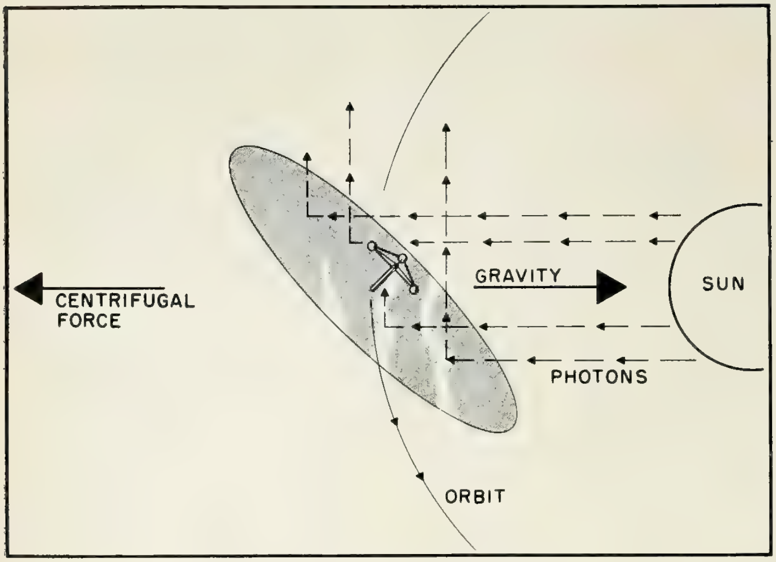
Los Alamos Scientists Study Solar Sail



HOW SOLAR sail utilizes photon propulsion.

Los Alamos, N. M.—A space vehicle propelled through space by a solar sail, using photon propulsion, is being studied by the Los Alamos Scientific Laboratory of the University of California.

The idea of using pressure of solar radiation for extra-orbital propulsion is not new. However, a small group of Los Alamos scientists, headed by Theodore Cotter, have devised means for spreading the sail once in outer space, for holding the sail in place, and for maneuvering the space ship and sail in relation to the sun and gravitational force.

Solar sailing is based on the use of the pressure of sunlight (photons) reflected by a large thin sail in much the same manner as sailboats use the wind. Sun pressure is pretty small—about 1/100th pound per acre—but since space is almost a perfect vacuum, there is no resistance and the sun pressure is free.

• **Two parts**—The space vehicle devised by Los Alamos would be in two parts—a large flat sail of equal weight with the attached payload. The two parts would be connected by a universal-like gear for maneuvering. The sail would be made from an extremely thin material such as a mylar-aluminum combination and could be put into orbit by a vehicle about the size of a *Vanguard* launcher.

Total weight would be around 50 pounds—25 pounds for the payload and 25 pounds for a sail 50 yards in diameter. The resulting device should do what satellites can never do—sample space at all distances from the earth. Satellites can only sample space from fixed orbits.

A solar sailing space ship would first be put into orbit around the earth, then the sail opened. Constant pressure of the sun on the sail would increase the orbit of the space ship. This maneuvering would continue for a matter of months until the solar sailing vehicle had gained enough distance from the earth to go into planetary orbit, and thus navigate in space without worrying about the gravitational fields of the earth or other planets.

A solar vessel would not be able to tack into the sun as a sailboat tacks into the wind; rather the solar sailing vehicle, now in planetary orbit, would play the sun's gravity against the centrifugal force of the space ship in orbit. Return to the earth would be made in the same way. It would decrease its orbital speed, and thus decrease its centrifugal force, and allow the sun to pull the vehicle towards the earth.

• **Centrifugal opening**—The solar sail may be opened by centrifugal force from spin given to it on leaving the rocket and would need no structural support, or it may be opened by using foam plastic which would be formed in ribs of the sail once the space ship leaves the rocket. In either case, the sails would be extremely fragile, but there are no stresses in space, so they would actually be overly strong for the mission to be performed. Once in space, mere meteoritic punctures to the solar sail are insignificant to the sail's function. Los Alamos feels that this indicates that a solar sailing space ship might remain serviceable for many years.

Device Switches Current Fast as Speed of Light

Sperry-Rand's Semiconductor Division recently announced details of a tiny semiconductor device that switches current off and on faster than light can travel one inch.

Time interval for switching is equal to or better than the speed measured by the best instruments available today—about 0.1 milli-microseconds, according to the company. Sperry scientists estimate that the speed of the switch is something around 0.05 milli-microseconds. Semiconductors in use today as switches operate about 100 times slower.

Working element of the switch is a semiconductor alloy junction formed by fusing aluminum to a tiny piece of silicon. The entire switching action takes place within the junction layer's diameter of two-thousandths of an inch and a thickness of four-millionths of an inch.

The atoms in the junction layer provide the mechanism for the switch. Operation depends on controlling the conditions for penetrating the lattice of the atoms and knocking planetary electrons out of the atom's shells.

• **Electrons accelerated**—The atomic mechanism in the layer blocks the flow of current until triggered by a "bit" of computer information in the form of a voltage pulse. The slight increase in voltage accelerates one or more electrons to speeds sufficient to knock new electrons out of their atomic shells. These in turn accelerate and knock more electrons free and so on. Each electron creates a chain reaction or "microplasma" which almost instantly spreads throughout the layer and carries current across the junction. In this condition, the switch is "ON."

Sperry calls this phenomenon the "avalanche effect" because the first electron is like the pebble that starts a landslide.

A slight decrease in voltage reduces the speed of the electrons so that the avalanche effect stops and the current-carrying plasma is swept out of the layer. In this condition, the switch is "OFF."

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JANUARY

Fifth National Symposium on Reliability and Quality Control in Electronics, Bellevue-Stratford Hotel, Philadelphia, Jan. 12-14.

Southwest Electronic Exhibit, Arizona State Fairgrounds, Phoenix, Jan. 21-23.

Institute of the Aeronautical Sciences, 27th Annual Meeting, Sheraton-Astor Hotel, New York. Honors Night Dinner, Jan. 27.

Fifth Annual Radar Symposium (classified), Rackham Bldg., University of Michigan, Ann Arbor, Jan. 27-29.

Society of Plastics Engineers, 15th Annual Technical Conference, Hotel Commodore, New York, Jan. 27-30.

Armour Research Foundation, Fifth Annual Midwest Welding Conference, Illinois Institute of Technology, Chicago, Jan. 28-29.

FEBRUARY

14th Annual Technical and Management Conference, Reinforced Plastics Division, Society of the Plastics Industry, Inc., Edgewater Beach Hotel, Chicago, Feb. 3-5.

IRE, AIEE 1959 Solid Circuits Conference, University of Pennsylvania, Philadelphia, Feb. 12-13.

1959 Engineering Exposition, Balboa Park, San Diego, Feb. 26-March 1.

MARCH

IRE, AIEE and Association for Computing Machinery, 1959 Western Joint Computer Conference, Fairmont Hotel, San Francisco, March 3-5.

Institute of the Aeronautical Sciences, Flight Propulsion Meeting (classified), Hotel Carter, Cleveland, March 5-6.

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Advertiser's Index

Aeroquip Corp. 31
Agency—Fred M. Randall Co.
Bendix Aviation Corp., Bendix Products Div. 22
Agency—MacManus, John & Adams, Inc.
Boeing Airplane Co. 4
Agency—Calkins & Holden, Inc.
Electro-Instruments, Inc. 36
Agency—Clyde D. Graham Adv.
Flight Refueling, Inc. 30
Agency—Emery Adv. Corp.
Goodyear Tire & Rubber Co., Aviation Products 3
Agency—Kudner Agency, Inc.
Grove Valve & Regulator Co. 35
Agency—L. C. Cole Co.
Hallamore Electronics Co., Div.-The Siegler Corp. 2
Agency—Cole, Fischer & Rogow, Inc.
Hexcel Products, Inc. 8, 9
Agency—L. C. Cole Co.
Hydromatics, Inc. 26, 27
Agency—Industrial Marketing Associates Adv.
National Aeronautics & Space Administration 12
Agency—M. Belmont Ver Standig, Inc.
North American Aviation, Inc., Missile Development Div. 24
Agency—Batten, Barton, Durstine & Osborn, Inc.
Northrop Aircraft, Inc., Radioplane Div. 19
Agency—Erwin Wasey, Ruthrauff & Ryan, Inc.
Scaife Co. 6
Agency—E. A. Korchnoy, Ltd.
Stromberg-Carlson Co., Div.-General Dynamics Corp. 10
Agency—The Rumrill Co., Inc.

EMPLOYMENT SECTION

Marquardt Aircraft Co. 33
Agency—Grant Adv., Inc.

Pax Universum—More Than Latin Phrase

Our government has gone to considerable pains in the past months to separate our civilian and military space activities, but the fact remains that to date there have been no space projects attempted or proposed in this country which do not have conceivable military applications.

On this page two weeks ago, m/r observed that while the U.S. was rather frantically moving off in all directions toward hopeful space conquest, we were doing so with no defined goal, no established program and no clear leadership or organization. M/r suggested, clearly mindful that it had a militaristic ring, that the U.S. goal should be:

"Until the world is guaranteed that space occupation of our solar system is for peaceful purposes, the United States can take no chance on its being dominated by someone else."

It also has a realistic ring. If the Soviets, under any guise, should gain dominance in the space envelope around the earth, they could blackmail the free world into abject submission—and quite happily would.

General Thomas D. White is a tough-minded military man. With a few peers he shares the lonely responsibility of being certain that the United States never drops its guard for that fatal moment which would permit a successful attack. Quoting General White, AF Chief of Staff:

"The few relatively brief periods of universal peace enjoyed by mankind in the past have been underwritten by potent national instruments. The British Navy, in the days of Pax Britannica, guaranteed an era of peace and progress by commanding the world's oceans. Today, the United States maintains a similar decisive force which operates in the now decisive medium of air. The natural extension of this decisive force into space is upon us—and we must meet this challenge to assure peace in the future. We must grow apace with the possibilities before us or perish for lack of what it takes to survive."

Most certainly his colleagues on the Joint Chiefs of Staff would agree that we must grow apace with the possibilities before us (in space) or perish for the lack of what it takes to survive. For no matter what the extent of civilian control imposed over them, these military leaders today bear a responsibility that is perhaps as great as any similar group in history ever faced. The land and the sea and the struggles for the control thereof have always been with us. Combat techniques in the air immediately above us came gradually, during and between two world wars. Space and its foreboding—if fascinating—challenge burst upon us with the speed of a Russian *Sputnik* orbiting around the earth every two hours.

It is pretty doubtful that the civilian leadership of the country is giving the service chiefs and their organizations the help which might reasonably be expected.

The gentlemen of the budget normally cut too deeply into all government programs knowing that the agencies involved will find ways of circumventing some part of the incisions. In the old, well-established programs, these budget cuts can be finessed because the very momentum of bulk—the Air Force $18 billion program, for instance—will carry them along. In the budgets for space projects there is no bulk, no backlog and no room to maneuver. Cuts there dig into the muscle. (ARPA's budget is and probably will be for 1960, woefully inadequate).

Our attitude before the world that the U.S. exploration of space is for peaceful purposes is part wistfulness and part the creation of a national posture. We must not go into space swinging a sword.

But both Congress and the National Space Council, which is headed by the President, should never lose sight of the fact that this peaceful space exploration will only be possible if the United States and the world's other free nations make it free; if we have a military capability in space which will prevent its domination by anyone else.

Again, m/r proposes that we must have a goal, a program and an organization for our space operation. From this can come the strength to help create a PAX UNIVERSUM, which may help to solve some of the nation's problems.

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NEW PRODUCT BRIEFS

M PROCESSOR. A new, 35mm cessor, second in a line of portable processors has been announced by Industrial Products Division of Fair- d Camera and Instrument Corpora- . The "Mini-Rapid 35" will process m film automatically. It is designed perate at speeds up to six feet per ute. Four hundred feet of leaderless can be processed at one loading. unit is designed to operate under ight conditions and use any size spool.

e No. 231 on Subscriber Service Card.

ENTIOMETERS. A 4-page brochure marizing key information on trimpot trimit lead screw actuated potenti- ters has been published by Bourns oratories, Inc. The brochure features ecification table listing available re- nces, terminal types, end settings, ar ratings, operating temperatures, dimensions of the models.

e No. 232 on Subscriber Service Card.

A-PROCESSING SYSTEM. Features nivac II data-processing system are ribed in a folder published by Rem- on Rand Division of Sperry Corpo- n. The Univac II computer offers a -speed memory system—the mag- -core memory, which Remington first introduced. It provides access 4,000 alphabetic or numeric char- s. It operates either on 80 or 90- nn cards, and provides direct re- ing of information on magnetic . It can also translate punched- r tape directly to magnetic tape nput. Output can be either on mag- tape, punched cards, hard copy aper tape. It reads and records in- ation at a pulse density of 250 acters per recording inch on mag- tape. Univac II handles either ac I or Univac II programs.

No. 233 on Subscriber Service Card.

MPONENTS. A set of basis transis- d digital computer circuit pack- has been developed by the Com- Division of Aeronutronic Systems, Individual circuits include flip-flops, logic boards, read amplifiers, amplifiers and blocking oscillators. component board contains two ical circuits except the logic board, contains 2-1, 2-2, 2-3, 1-4, 2-5 ion "and" gates, and nine "or" . DC pulse gating techniques per- operation of 75 pulse gates from output of the flip-flop and read fier, at frequencies up to 500 kc.

No. 234 on Subscriber Service Card.

RATIOMETER. An ac-dc digital ratiometer, model 1594, for computers and control system applications has been announced by Performance Measurement Co. Range of ratios that can be measured directly in numerical values is 0 to 1.000. Input voltages range from 0 to 6.3 volts ac and 0 to 6 volts dc. With a high impedance input, this instrument measures ac and dc voltage ratios with a rated accuracy of ±0.10% full scale. For measuring ac ratios, the digital ratiometer accepts input voltage at a nominal frequency of 400 cps. Frequency variations as high as ±20 cps and resultant phase shift have no effect on the ratiometer output reading. Readability of the model 1594 digital ratiometer is one part in 1000. Reference input impedance for both ac and dc ratios is 1000 ohms. The signal input impedance for the ac section of the ratiometer is 20 megohms minimum, and for the dc section it is 10 megohms. Power input to the instrument is 115 volts, 60 cps and 50 watts.

Circle No. 235 on Subscriber Service Card.

TRANSISTOR. A germanium p-n-p alloy-junction transistor (RCA-2N331) for audio-frequency amplifier service has been announced by the RCA Semiconductor and Materials Division. The 2N331 has a current-transfer-ratio characteristic which is essentially constant over the useful operating current range for the device. This feature, in addition to low collector-and-emitter-cutoff currents, low base resistance, a typical power gain of 44 decibels, and a typical noise factor of 9 decibels, gives low-power audio-frequency amplifier service.

Circle No. 236 on Subscriber Service Card.

ACCELEROMETERS. A line of 30, ungrounded piezoelectric accelerometers, designed to eliminate circulating ground currents, has been announced by Gulton Industries, Inc. The ungrounded units are produced in four classes including unidirectional, tridirectional, high temperature and extra high temperature. Normal temperature units, Series A, Glennite Accelerometers, operate from −65° to +250°F. Series AHT, high temperature units operate from −65° to +350°F. The AXT series, extra high temperature units operate from −100° to +525°F. Featuring extremely high sensitivity, small size and weight and wide temperature ranges, all units reportedly operate with an accuracy of ±5% or better and a linearity of ±1%.

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

• • Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

• • New Missile Products

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

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MISSILE LITERATURE

CERAMIC TRANSDUCERS. Publication of a technical brochure on the subject of a new series of Glennite high temperature, pizoelectric ceramic transducers, is announced by Gulton Industries, Inc. Described in the brochure are the exceptionally high Curie points of these transducers, that have made it possible to reach higher output voltages per unit input pressure than can be reached with conventional ceramics. Because no cooling is required, applications for the transducers highlight uses in ordnance systems and high temperature electromechanical sensors. The eight-page, two-color, illustrated brochure also describes other applications.

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DATA SYSTEM. A brochure is now available from the Epsco Systems Division. It describes the new Mark I basic short delivery automatic PDM-to-Digital Computer Format Telemetry Data System. Among the many features in this production type data system is the unparalled absolute accuracies in excess of 0.1%, and the fact that the entire PDM data to computer format process is completely automatic.

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ALLOY. An alloy that combines the advantages of excellent resistance to corrosion with good strength at high temperatures is the subject of a new 12-page booklet. Latest information on hastelloy Alloy B, one of a group of nickel-base alloys bearing this trade mark, has been consolidated. The alloy was developed primarily to offer chemical processors and excellent resistance to hydrochloric acid over a wide range of concentrations and temperatures. In addition, Alloy B has become a valuable high-temperature material because it retains over two-thirds of its room temperature yield strength at 1600 deg. F. It is a product of Haynes Stellite Company, Division of Union Carbide Corp.

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DESKTOP COMPUTER. Data File 340 describing Donner Scientific Company's new Model 3400 desktop analog computer is now available. The model 3400 performs the functions of general purpose analog equipment. In design, analysis, or control problems, it is a time-saving model of an arbitrary physical system. Easily measured varying voltages represent the physical variables of the problems. Measurement of the voltage yields complete information on the system. Parameters can be altered with the twist of a dial.

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CARBON-GRAPHITE. A informative reference on the composition, qualities and applications of carbon-graphite is offered by the Ohio Carbon Company in an 8-page brochure. The brochure serves as an idea book for carbon-graphite applications. Charts and tables provide data on qualities of sceleroscope hardness, density, transverse and compressive strength, oxidizing temperature limitations, performance in sliding contact with various modern bearing metals, tensile strength-to-specific gravity, and thermal conductivity. Special development and testing facilities are outlined.

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BROCHURE. A 36-page brochure co ering a complete range of services i rocket and missile systems is availabl from Cooper Development Corporatio The brochure details the company work in propulsion, electronics, tel metry, instrumentation, ground suppor upper atmospheric research, meteorol gical studies, target systems and relate activities. Engineering, production, an quality control facilities are describe and a special section is devoted to sy tems and components.

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ANALYZER. Theoretical and practical a alysis of FM is the subject of the late issue of "The Panoramic Analyzer," publication devoted to application dat by Panoramic Radio Products, In Basic FM theory, modulation, FM spe trum measurements, and combined A and FM are discussed. This issue ou lines the uses of FM commercially well as in the missile and aircraft fiel FM background, and methods of mon toring and maintenance. Common typ of measurements are covered—FM d viation calibration, monitoring chann utilization, malfunction analysis, etc.

Circle No. 209 on Subscriber Service Car

PULSE TRANSFORMERS. A technic bulletin describing a series of miniatu encapsulated pulse transformers woun on high permeability ferromagnet cores has been published by Techn trol Engineering Company. The bullet describes the T series pulse transforme having a range of pulse widths from 0. to 25 microseconds for vacuum tube transistor blocking oscillator and inte stage coupling applications. The bulle tin gives electrical and environment specifications and includes drawings different case styles with dimensions.

Circle No. 208 on Subscriber Service Car

DUTY LIMIT SWITCHES. 16-page cata log, Number 84, covering a complet line of heavy duty limit switches, ha been published by Micro Switch, a di vision of Minneapolis-Honeywell Regu lator Company. The catalog gives de tails of three types of micro switc heavy-duty limit switches for industria uses—the plug-in "200LS" series, th "LS" series, and the "ML" switches

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MISSILE SYSTEM CAPABILITIES. An 8 page two-color brochure covers thi firm's work and facilities in missile sys tem development and production. Th brochure illustrates and describes sys tems, subsystems and components fo many advanced missiles. It lists the com pany's current projects such as guidanc and control systems, missile-borne sub systems, ground support equipment, pro duction test equipment and specialize components.

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SERVICES AND FACILITIES. New 6 page Bulletin 5801 describes laborator and field testing facilities and service available from United States Testing Company, Inc. Included is a descriptio of the company's engineering facilitie and services—environmental studies t electronics, instrument calibration, and reliability testing and failure analysis.

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

• • Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

• • New Missile Products

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

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